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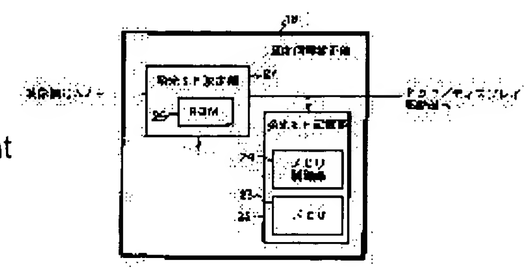
(54) DEVICE AND METHOD FOR GRADATION DISPLAY

(57)Abstract:

PROBLEM TO BE SOLVED: To conduct a correct compensation for luminance signals and to greatly increase the dynamic image spurious profile prevention effect by determining the combination of the light emitting subfields, which are suitable in generating the desired luminance in a present frame from the past subfield light emitting history, and the luminance signals in the present frame.

SOLUTION: A light emitting subfield storage section 22 stores the light emitting subfields of the past frames which consists of a previous frame or the previous frame and the frame that is one of the frames existed before the previous frame. A light emitting subfield determining section 21 is provided with a ROM 25 in which the data, that indicate which subfield should be light emitted in order to generate a desired luminance given by the luminance signals, are beforehand stored as the table corresponding to the subfield light emitting pattern in the previous field. Then, a determination is made for the combination of the light emitting subfields which are suitable to generate the desired luminance in the present frame.



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JAPANESE [JP,11-224074,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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* NOTICES *

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1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Gradation display which is characterized by providing the following and which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame. A luminescence subfield determination means to determine the combination of the subfield luminescence history of the past memorized by this luminescence subfield storage means, and the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.
[Claim 2] It is the gradation display characterized by being a means to memorize only a luminescence subfield [in / a front frame / on gradation display according to claim 1 and / in the aforementioned luminescence subfield storage means].
[Claim 3] Gradation display which is characterized by providing the following and which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame. A luminance-signal storage means to memorize the luminance signal in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame. The subfield luminescence history of the past memorized by this luminescence subfield storage means and this luminance-signal storage means, and the history of the past luminance signal. A luminescence subfield determination means to determine the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.
[Claim 4] It has the following. the aforementioned luminescence subfield determination means The subfield luminescence pattern in the frame of the past in adjoining L pixels (L is the two or more natural numbers) is read from the aforementioned luminescence subfield storage means. From this subfield luminescence pattern and the luminance signal in the present frame in the aforementioned L pixels Each aforementioned L pixel is received in the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame. Gradation display which is characterized by being a means to determine and which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame. A luminescence subfield determination means to determine the luminescence subfield in the present frame.
[Claim 5] It has the following. the aforementioned luminescence subfield determination means The luminance signal in the front frame in adjoining L pixels (L is the two or more natural numbers) Read from the aforementioned luminance-signal storage means, and from this and the luminance signal in the present frame in the aforementioned L pixels Each aforementioned L pixel is received in the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame. Gradation display which is characterized by being a means to determine and which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield. A luminance-signal storage means to memorize the luminance signal in a front frame. A luminescence subfield determination means to determine the luminescence subfield in the present frame.
[Claim 6] A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame in the gradation display which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield. At

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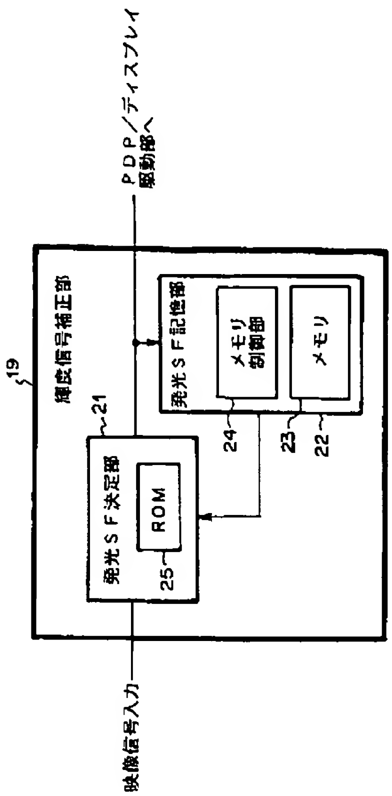
least one frame before a front frame or a front frame, and this front frame. It is the gradation display equipped with the above, and is characterized by being a means to determine the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole to each aforementioned L pixel.
[Claim 7] The unit of the pixel which determines a luminescence subfield as either of the claims 4, 5, and 6 in the gradation display of a publication, gradation display characterized by L pixels being 2 pixels.
[Claim 8] It is the gradation display characterized by having a means to determine the combination of the luminescence subfield in each pixel so that the pixel more brightly displayed compared with a luminance signal [in / each pixel / on gradation display given in either of the claims 4, 5, 6, and 7 and / in the aforementioned luminescence subfield determination means] and the pixel displayed more darkly may be arranged in the shape of a checker board on a screen.
[Claim 9] It is the gradation display characterized by being a means by which the aforementioned luminescence subfield determination means determines the luminescence subfield in each pixel in gradation display according to claim 1 to 8 using a perceptron neural network.
[Claim 10] The gradation method of presentation characterized by determining the combination of the luminescence subfield suitable for generating desired brightness in the present frame in the gradation method of presentation which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield from the luminance signal in the luminescence subfield luminescence history in a frame and the present frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame.
[Claim 11] In the gradation method of presentation which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield The subfield luminescence history of the past in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The history of the luminance signal of the past in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The gradation method of presentation characterized by determining the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.
[Claim 12] In the gradation method of presentation which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield The subfield luminescence pattern in the frame of the past which consists of the front frame or front frame in adjoining L pixels (L is the two or more natural numbers), and at least one frame before this front frame, The gradation method of presentation characterized by determining the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.
[Claim 13] In the gradation method of presentation which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield The luminance signal in the front frame in adjoining L pixels (L is the two or more natural numbers), The gradation method of presentation characterized by determining the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.
[Claim 14] The subfield luminescence pattern history in the frame of the past which consists of at least one frame before the front frame or the front frame, and this front frame in adjoining L pixels (L is the two or more natural numbers) in the gradation method of presentation which divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield. At least one frame before the front frame in the aforementioned L pixels or a front frame, and this front frame. It is the gradation method of presentation equipped with the above, and is characterized by determining the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole to each aforementioned L pixel.

[Translation done.]

Drawing selection [Representative drawing]



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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to the gradation display suitable for the animation false coutour suppression in the gradation display of display, such as a plasma display panel, and the gradation method of presentation about gradation display and the gradation method of presentation.
[0002]
[Description of the Prior Art] generally, a plasma display panel (it is hereafter called PDP for short) does not have a flicker with thin shape structure, and it is possible that a display contrast ratio is large and for it to be comparatively alike and to consider as a big screen, a speed of response is quick, and it has many features -- multicolor luminescence is also possible -- by use of a fluorescent substance with the spontaneous light type For this reason, in the field of computer-related display, the field of a color picture display, etc., it is coming to use widely in recent years.
[0003] There are an alternating current electric discharge type thing which an electrode is covered with a dielectric by the method of operation, and is indirectly operated in the state of alternating current electric discharge, and a direct-current-discharge type thing which an electrode is exposed to discharge space and operates in the state of a direct current discharge in this PDP. Furthermore, there are a memory operation type which uses the memory of an electric discharge cell as a drive method, and a refreshment operation type which does not use it as alternating current electric discharge type. In addition, the brightness of PDP is proportional to the number of times of electric discharge, i.e., the number of repeats of a pulse voltage, mostly. In the case of the above-mentioned refresh type, since brightness will fall if display capacity becomes large, it is mainly used to PDP of small display capacity.
[0004] Drawing 11 is a cross section which illustrates the outline of the composition of one display cell of alternating current electric discharge memory operation type PDP. Opposite arrangement of the two insulating substrates (a display side glass substrate, rear-face side glass substrate), the front face where this display cell consists of glass, and a tooth back, 1 and 2 is carried out. On the insulating substrate 1 by the side of opposite, the septum 34 formed on the wrap dielectric layer 4 and the dielectric layer 4 in the transparent scanning electrode 32 and the transparent maintenance electrode 33, and the scanning electrode 32 and the maintenance electrode 33 and the protective layer 36 which consists of the magnesium oxide which protects a dielectric 4 from electric discharge are formed. Moreover, on the insulating substrate 2 by the side of opposite, the data electrode 5 formed by intersecting perpendicularly with the scanning electrode 32 and the maintenance electrode 33 and the fluorescent substance 9 which changes into the light 35 the ultraviolet rays which generate this data electrode 5 by the wrap dielectric layer 7 and electric discharge of a discharge gas are formed.
[0005] The space between an insulating substrate 1 and an insulating substrate 2 is filled up with the discharge gas which consists of those mixed gas, such as helium, neon, and a xenon, the discharge-gas space 37 is formed, and a septum 34 is formed in order to divide a display cell, while securing this discharge-gas space 37.
[0006] Next, with reference to drawing 11 , electric discharge operation of the selected display cell is explained. If the pulse voltage exceeding an electric discharge threshold is impressed between the scanning electrode 32 and the data electrode 5 and electric discharge is made to start, corresponding to the polarity of this pulse voltage, the charge of positive/negative will be attracted by the front face of the dielectrics 4 and 7 of both sides, and will produce deposition of a charge. Since it becomes the above-mentioned pulse voltage and reversed polarity, even if the effective voltage inside a cell falls with growth of electric discharge and the above-mentioned pulse voltage holds constant value, the equivalence internal voltage resulting from deposition of this charge, i.e., wall voltage, cannot maintain electric discharge, but it ****** it at last. Since it is superimposed on the part of wall voltage as an effective voltage when the maintenance pulse which are wall voltage and the pulse voltage of like-pole nature is impressed between the scanning

electrodes 32 and the maintenance electrodes 33 which adjoin next, even if the voltage swing of a maintenance pulse is low, it can discharge exceeding an electric discharge threshold.

[0007] Therefore, it becomes possible by continuing impressing a maintenance pulse between the scanning electrode 32 and the maintenance electrode 33 to maintain electric discharge. This function is an above-mentioned memory. Moreover, the scanning electrode 32 or the maintenance electrode 33 can be made to stop the above-mentioned maintenance electric discharge by impressing the elimination pulse which is the pulse of a low battery with wide width of face which neutralizes wall voltage, or a pulse about [of width of face / narrow] a maintenance pulse voltage.

[0008] Drawing 12 is drawing showing electrode wiring of the line of a jxk individual, and the panel for a dot-matrix display which arranged the display cell in the shape of [which consists of a train] a matrix. It has the scanning electrodes Sc1, Sc2, --, Scj and the maintenance electrodes Su1, Su2, --, Suj which were arranged in parallel as a line electrode, and has the data electrodes D1, D2, --, Dk which intersected perpendicularly with these scanning electrode and the maintenance electrode as a train electrode, and were arranged. A round term of a drive of this panel is written in with a pre-discharge period, consists of a conducting period and a maintenance conducting period, repeats this, and obtains desired graphic display.

[0009] A pre-discharge period impresses the pre-discharge elimination pulse for extinguishing the charge which checks write-in electric discharge and maintenance electric discharge among the wall charges generated by impression of the pre-discharge pulse which it is [pulse] a period for generating an activity particle and a wall charge, and makes all the display cells of the PDP panel discharge simultaneously in discharge-gas space, and a pre-discharge pulse, in order [which was stabilized in the write-in conducting period] to write in and to acquire an electric-discharge property. A maintenance conducting period is a period which maintenance electric discharge is carried out [period] in order to obtain desired brightness, and makes the display cell which discharged by writing in in a write-in conducting period emit light.

[0010] In a pre-discharge period, a pre-discharge pulse is first impressed to the maintenance electrodes Su1, Su2, --, Suj, and electric discharge is caused in all display cells. Then, an elimination pulse is impressed to the scanning electrodes Sc1, Sc2, --, Scj, elimination electric discharge is generated, and the wall charge deposited by the pre-discharge pulse is eliminated.

[0011] Then, it writes in, and in a period, a scanning pulse is impressed to the scanning electrodes Sc1, Sc2, --, Scj line sequential, further, a data pulse is impressed alternatively, and is written in the data electrode Di (1 <=i<=k) in the cell which should be displayed corresponding to graphic display data, electric discharge is generated, and a wall charge is generated.

[0012] Finally in a maintenance conducting period, only the display cell which caused write-in electric discharge causes maintenance electric discharge continuously by the maintenance pulse, and luminescence operation of the 1st page is completed.

[0013] Drawing 13 is made into an example and the subfield display by the scanning maintenance separation drive used used by AC type color plasma display is explained. Although the 1 field is made into about 1/60 second whose flicker is not usually visible, as shown in drawing 13 , this is divided into six subfields of SF6 from the subfield SF 1 which consists of a scanning interval and a conducting period. In the scanning interval of a subfield SF 6, writing is performed to each pixel based on the indicative data of B5 of the most significant bit. After complete writing is completed, a maintenance electric discharge pulse is impressed all over a panel, and only the write-in pixel is indicated by luminescence. Next, the same drive is performed also in a subfield SF 5. In the maintenance conducting period of each subfield, in order to obtain sufficient brightness, 128 times, in SF1, 64, 32, and 16 or 8 times of maintenance electric discharge pulses are impressed, and emit light from a subfield SF 4 256 times by the subfield SF 6 at a subfield SF 5, respectively.

[0014] Although the rapidity which performs a scan in a short time and writing is required in order to have produced adoption of such a subfield method from the need of modulating luminescence brightness in the number of times of luminescence, or a luminescence period and to scan multiple times during the 1 field naturally, improvement in the write-in performance of a plasma display panel is achieved in recent years, writing has become possible and at least three or less microseconds also of full color displays of 256 gradation by eight subfields have also been realized.

[0015] Although a good gradation display is reproduced by such subfield method in the case of a still picture, disturbance occurs with an image in animation display. For example, when the picture from which a luminosity changes smoothly like a person's cheek moves in a screen top, a dark profile, and a bright profile or a different profile of a color appears into the portion of the cheek which should be a picture smooth originally. Moreover, a color gap, the feeling of a fall of resolution, etc. are brought about. Such animation false coutour is very conspicuous on the boundary

which advances to a high order bit in a smooth gradation change, and has the problem which spoils display grace and quality of image remarkably.

[0016] Drawing 14 shows a part of gradation realized with the combination of eight subfields SF8-SF1 by which weighting was carried out to the 8-bit binary digit B7, B6, B5, B4 and B3, B-2, and the brightness 128, 64, 32, 16, 8, 4, 2, and 1 respectively corresponding to B1 and B0. The display of 256 gradation is attained by combining these subfields. That is, the brightness of 256 gradation of each pixel can be expressed in the 8-bit binary digit of B7-B0. It becomes the natural picture which was made to display a picture one by one by the subfields SF8-SF1 which expressed the existence of brightness 128, 64, 32, 16, 8, 4, 2, and 1 in a binary digit B7-B0, and was expressed by the visual storage effect by halftone.

[0017] In drawing 14 , when one gradation changes from brightness 127 to especially the brightness 128, all the values of all of B6-B0 change from "1" to "0" a lot, and B7 changes to "1" from "0." For this reason, supposing it makes light emit by the time order of the subfield SF 8 of the most significant from the subfield SF 1 of the least significant, a luminescence period will change from the first portion of the field to the section remarkably in the second half, consequently animation false coutour will occur.

[0018] Some methods are proposed in order to solve this problem. the Institute of Electronics and Communication Engineers paper magazine -- in Mr. Takigawa's paper "TV display by AC plasma panel" indicated from 56 pages to 62 pages of '77/VolJ60-ANo.1 A bit winds [the center-of-gravity position of brightness within a time / of the 1 field]. wind, and a riser and before and after falling It is supposed that it is effective to arrange a subfield so that it may not move as much as possible, and the subfield array of SF3, SF4, SF5, SF1, and SF2 which allotted the luminescence period of a high order bit to the center section in the example of 5 bits, i.e., 32 gradation displays, is effective in suppression of animation false coutour. Moreover, it is also effective to decrease the display time in 1 field, in the example of an experiment, by shortening a display period at the time of the quadrant of the 1 field, it combines with the above-mentioned subfield array, and the good display is realized.

[0019] moreover, in the paper "the middle means of displaying of television using the memory type discharge-in-gases panel" of Mr. Konoue of EID 90-9 of the electronic-intelligence communication society technical report reported in 1990 The time interval from the bit of the beginning of the field to the bit of the last of the next field It is supposed that animation false coutour will be improvable by considering as less than 20 mses which are the critical fusion frequency of human being's visual sense. Like above-mentioned Mr. Takigawa's method, a subfield cannot be arranged over the whole 1 field, but it can consider as less than 20 mses by stuffing one side, and it is supposed that animation false coutour will be improved.

[0020] Moreover, it is supposed also by dividing and arranging the bit of a high order with a long luminescence period that this condition can be fulfilled. In a 8-bit display, are divided B7 of a high order into SF 8-1 and SF 8-2, and B6 is divided into two at SF 7-1 and SF 7-2, respectively. By arranging the 1 field with 10 subfield composition in order of SF 7-1 and SF 8-1 which have arranged dispersedly the subfield divided respectively, SF1, SF2, SF3, SF4, SF5, SF6 and SF 7-2, and SF 8-2 Time from the bit of the beginning of the field to the bit of the last of the next field can be made into 18.8 mses, and it is reported that the gradation disorder of an animation has been improved.

[0021] in addition, although the most significant bit of a binary digit which expresses the weight of brightness with the above-mentioned paper is set to B1 and the subfield of the most significant corresponding to it is set to SF1, in this invention, it unifies into expression generally used in the information processing field, and the subfield of Bn-1 and the least significant is expressed [a least significant bit] for B0 and the most significant bit of n figures as SF1

[0022] As the above optimization of a subfield array, shortening of field time or a luminescence display period, or methods other than the method of dividing the long subfield of a luminescence period, an amendment is added to a status signal and the method of suppressing animation false coutour is learned by making a subfield without a lighting schedule turn on, or making the subfield of a lighting schedule switch off conversely. In JP,8-54853,A, an animation false coutour field (the fake image field is indicated by JP,8-54853,A) is detected, it distinguishes to it whether the brightness of this animation false coutour field is brighter than original brightness, and the idea of controlling luminescence of the pixel of this field based on this distinction result is indicated. Furthermore, an animation lost-motion vector is detected to JP,8-123355,A and JP,8-211848,A, and the method of controlling luminescence of a pixel to suppress the animation false coutour generating is expected to be using it is indicated. The bit produced by brightness change winds in JP,9-102921,A, a riser is detected in each pixel to it, and the method of rectifying an indicative data based on the result is indicated. Moreover, the method of asking JP,9-34401,A for the amendment signal for suppressing animation false coutour beforehand, reading this as a look-up table, and writing in exclusive memory (ROM) is indicated.

[0023] Drawing 15 is the block diagram showing the signal amendment method indicated by JP,9-34401,A. In case it rectifies by this method, the frame memory is made to memorize the luminance signal of the past frame, an amendment signal is read from ROM by making this and the luminance signal in the present frame into the address, this is added to the luminance signal in the present frame, and it sends to the drive control circuit of PDP. The amendment data for suppressing animation false coutour which ROM should be made to memorize beforehand here are decided based on survey data.

[0024]

[Problem(s) to be Solved by the Invention] In the above conventional technology, animation false coutour is not fully suppressed and, still, the method by optimization of the order of a subfield does not have it to high-definition graphic display. [enough] Moreover, by the method of dividing shortening of field time, shortening of a luminescence display period, or many subfields, in order to demonstrate the depressor effect of sufficient animation false coutour, it is necessary to shorten a scanning interval considerably. Although this can respond in the plasma display with a small display capacity by which shortening of a scanning interval is permitted, animation display of many gradation is rather desired on the big display of display capacity, and it becomes difficult to shorten a scan time still more sharply and to drive it in this case.

[0025] By working effectively, even if many subfields are not used for the method of suppressing animation false coutour by signal amendment, at this point, although it is advantageous, it is hard to say that the load of movement detection processing is large and the method of detecting the motion vector of an animation and controlling luminescence of a pixel is practical at present.

[0026] Then, although a method of performing a signal amendment, without performing movement detection processing was desired, in this case, by the Prior art, animation false coutour could not fully suppress in fact, but there was a trouble that it was still inadequate, to high-definition graphic display too.

[0027] Analysis of this reason mentions the point of having determined the amendment signal in the present frame using the luminance signal in the past frame, with the conventional signal amendment technology as the 1st trouble. For For example, when luminescence brightness changes to 31 from 32 in subfield arrangement of drawing 13 , time to change in the state where SF6 quenches and SF1-SF5 are emitting light, consequently for luminescence become a non-dense from the state where only SF6 is emitting light, at the time of changes of a frame arises, for this reason, a screen becomes dark for a moment, and animation false coutour occurs. An amendment signal (for example, +10) is added for this to an amendment sake at the luminance signal in the present frame, and brightness 41 is displayed. However, with the following frame, since having considered the case where you want to generate brightness 41 with the following frame here the pixel displayed brightness 41 in fact with the present frame, although an amendment is unnecessary **** Since the luminance signal from the first in the present frame was 31, by the conventional method, the contradiction in which an amendment signal (for example, -7) when a luminance signal changes to 41 from 31 will be read, and it will be added had happened.

[0028] Although the brightness which not only the luminescence state in the last frame but the luminescence state of two or more frames ago is perceived with the present frame is affected in fact as the 2nd trouble, by the conventional method, this point is not taken into consideration but the point of having determined the amendment signal only from the luminance signal in the present frame and the luminance signal of one frame ago is mentioned. For this reason, a high amendment of precision was not completed by the conventional method.

[0029] Although the signal amendment was performed for every pixel by the conventional method as the 3rd trouble, no matter what amendment it may perform then for every pixel in fact, the point that sufficient amendment may be unrealizable is mentioned.

[0030] (The purpose of invention) this invention aims at offering the gradation display and the gradation method of presentation which suppress disturbance of animation false coutour remarkably in view of the above-mentioned technical problem.

[0031]

[Means for Solving the Problem] In the gradation display which the gradation display of this invention divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The subfield luminescence history of the past memorized by this luminescence subfield storage means, It is the gradation display characterized by having a luminescence subfield determination means to determine the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.

[0032] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, A luminance-signal storage means to memorize the luminance signal in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The subfield luminescence history of the past memorized by this luminescence subfield storage means and this luminance-signal storage means, and the history of the past luminance signal, It is the gradation display characterized by having a luminescence subfield determination means to determine the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.

[0033] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It has a luminescence subfield determination means to determine the luminescence subfield in the present frame. the aforementioned luminescence subfield determination means The subfield luminescence pattern in the frame of the past in adjoining L pixels (L is the two or more natural numbers) is read from the aforementioned luminescence subfield storage means. From this subfield luminescence pattern and the luminance signal in the present frame in the aforementioned L pixels It is the gradation display characterized by being a means to determine the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame to each aforementioned L pixel.

[0034] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. It has a luminance-signal storage means to memorize the luminance signal in a front frame, and a luminescence subfield determination means to determine the luminescence subfield in the present frame. The aforementioned luminescence subfield determination means the luminance signal in the front frame in adjoining L pixels (L is the two or more natural numbers) Read from the aforementioned luminance-signal storage means, and from this and the luminance signal in the present frame in the aforementioned L pixels It is the gradation display characterized by being a means to determine the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame to each aforementioned L pixel.

[0035] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, A luminance-signal storage means to memorize the luminance signal in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It has a luminescence subfield determination means to determine the luminescence subfield in the present frame. the aforementioned luminescence subfield determination means The subfield luminescence pattern history in the frame of the past in adjoining L pixels (L is the two or more natural numbers), The luminance-signal history in the frame of the past in the aforementioned L pixels, respectively The aforementioned luminescence subfield storage means, And read from a luminance-signal storage means and it sets on the present frame from these and the luminance signal in the present frame in the aforementioned L pixels. It is the gradation display characterized by being a means to determine the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole to each aforementioned L pixel.

[0036] In the gradation method of presentation which the gradation method of presentation of this invention divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield The luminescence subfield luminescence history in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.

[0037] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The subfield luminescence history of the past in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The history of the luminance signal of the past in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield which is

suitable for generating desired brightness in the present frame from the luminance signal in the present frame.

[0038] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The subfield luminescence pattern in the frame of the past which consists of the front frame or front frame in adjoining L pixels (L is the two or more natural numbers), and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.

[0039] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The luminance signal in the front frame in adjoining L pixels (L is the two or more natural numbers), It is the gradation method of presentation characterized by determining the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.

[0040] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The subfield luminescence pattern history in the frame of the past which consists of at least one frame before the front frame or the front frame, and this front frame in adjoining L pixels (L is the two or more natural numbers), The luminance-signal history in the frame of the past which consists of the front frame in the aforementioned L pixels or a front frame, and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield which is suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.

[0041] (Operation) Although the luminescence pattern of the subfield in the past frame which is suitable for the present frame from a luminance signal from the first and the luminance signal of the present frame was determined by the already explained signal amendment method of drawing 15 In this invention, it is not a luminance signal from the first in the past frame. The signal which rectified to the luminance signal, i.e., the signal showing the subfield made to actually emit light, is memorized in the luminescence subfield storage section. the luminescence subfield determination section This signal (signal showing the subfield made to actually emit light), A desirable amendment is determined from the luminance signal in the present frame, and the luminescence pattern of a subfield which was most suitable with the present frame is determined.

[0042] When the input luminance signal in the past frame differs from the signal made to actually emit light, the contradiction of the conventional method that an amendment will be performed based on a different input luminance signal from the thing made to actually emit light is canceled by this, and remarkable animation false coutour depressor effect can be realized by it.

[0043] Moreover, in this invention, the luminescence subfield storage section which has two or more frame memories is made to memorize the subfield luminescence pattern in two or more past frames, and the luminescence subfield determination section determines the subfield luminescence pattern which was most suitable with the present frame from the subfield luminescence pattern of these past, and the luminance signal in the present frame. Consequently, according to the time change history of an input luminance signal, the signal amendment as which not only the luminescence subfield in the last frame but the influence of the luminescence subfield in the frame of two or more frames ago was considered, and the determination of a luminescence subfield are attained, and a high amendment of precision can be realized more.

[0044] Furthermore, 2 pixels which the luminescence subframe storage section is made to memorize the subfield luminescence pattern in the past frame, and adjoins in this invention (generally L pixels.) The luminescence subfield determination section determines which subfield should be made to emit [in / each / 2 pixels / above-mentioned] light with the luminescence subfield of the past / in / two or more positive integers / in L], and a 2 above-mentioned pixels / in the present frame / luminance signal to the present frame. Even when amendment sufficient in the amendment processing performed for every pixel like the conventional method is impossible, 2 pixels of amendment errors are made to cancel as a whole, it becomes possible to generate the adjoining brightness for which it asks on the average with a more sufficient precision, and the depressor effect of remarkable animation false coutour is obtained by this. It is as follows when supplemented with why this becomes possible. If the number of the subfields arranged all over 1 field is set to n, the number of the luminescence states which each pixel can take in the 1 field will become as the n-th power

of 2 in general. By the method of performing a brightness amendment for every pixel, you have to choose the optimal luminescence state out of these states where it was restricted. When generating the brightness for which it asks on the average as a whole 2 pixels as opposed to it, the luminescence state more optimal out of many possible luminescence states can be chosen. In this case, since "it is un-emitting light 2 pixels", "2 pixels emitting light", and three kinds of "only one of pixels emit light" exist for every subfield, a possible luminescence state can choose the luminescence state optimal out of the possible luminescence state as the n-th power of 3 as the whole. Therefore, since the optimal luminescence state can be chosen from more luminescence states by performing a signal amendment per 2 pixels in this way, it becomes possible to generate the average brightness for which it asks with a more sufficient precision.
[0045]
[Example] Hereafter, with reference to a drawing, it explains in detail based on the suitable example of this invention. (The 1st example) The plasma display panel concerning this example is explained first.
[0046] Drawing 5 shows the created plasma display panel for a 640x480 color-picture display. On the glass substrate 1 which becomes a display side, the dielectric layer 4 which adhered to the magnesium-oxide film is formed in the front face with the field discharge electrode 3 which a metaled bus electrode turns into from the transparent electric conduction film by which the laminating was carried out, and it is formed so that the septum 6 of the shape of a still blacker grid may decide a pixel.
[0047] On the glass substrate 2 by the side of a rear face, the data electrode 5 and the white septum 8 of the shape of the white dielectric layer 7 and a stripe are formed, and the fluorescent substance 9 which emits light by three primary colors is distinguished by different color with in the slot of the white septum 8.
[0048] Between two glass substrates, the discharge gas which consists of Helium helium, neon Ne, and a xenon Xe is enclosed, and a panel is completed. In the data electrode 5, 1920 and the field discharge electrode 3 consist of a scanning electrode and a maintenance electrode, and 480 are formed, respectively.
[0049] A scanning pulse is impressed to a scanning electrode one by one, and a data pulse is impressed to the data electrode 5 chosen synchronizing with it. After this line sequential scanning crosses all over a pulse and is performed, maintenance electric discharge is made to perform all over a panel, and color luminescence is obtained. The gradation data digitized during the field for 1/60 second were made to correspond, such operation was performed by two or more subfields, and animation display which has halftone was performed.
[0050] Drawing 3 is the block diagram showing the rough composition of this example. The luminance signal inputted from the outside is sent to PDP / display drive control section 20, after being changed in the luminance-signal amendment section 19, and luminescence of PDP is performed.
[0051] Drawing 4 is the block diagram showing the outline of the composition of PDP / display drive control section. The data electrode 5 (5-1 - 5-m) which has come out of the panel is connected to the data driver 10 for [every], it writes in by the data driver 10, and a data pulse is impressed to a scanning interval at each data electrode 5-1 - 5-m. Moreover, the scanning electrode 11 (11-1 - 11-n) is individually connected to the scanning driver 12. Wall electrification required for future luminescence is accumulated with the data pulse which the scanning pulse was impressed to the scanning electrode 11-1 - 11-n by this scanning driver 12, and was impressed to the data electrode 5.
[0052] On the other hand, the maintenance electrode 13 is connected in common along with all the display lines of PDP. And a maintenance pulse is impressed by the maintenance driver 14 all over PDP through the maintenance electrode 13.
[0053] The data driver 10, the scanning driver 12, and the maintenance driver 14 are controlled by the driver control circuit 15. The driver control circuit 15 is constituted including the data driver control circuit, the scanning driver control circuit, and the maintenance driver control circuit (it omits on a drawing). It connects with the data driver control circuit, and a data driver control circuit incorporates an indicative-data signal (R7-0, G7-0, B7-0) from a frame memory 16, and the data driver 10 supplies the data which should be chosen from there to the data electrode 5. The signal inputted into the frame memory 16 from the luminance-signal amendment section is supplied and memorized after receiving pretreatment of a reverse gamma correction etc. in the pretreatment section 17.
[0054] Moreover, it connects with the scanning driver control circuit, and the scanning driver 12 answers the vertical synchronizing signal VSYNC which is a signal which controls the start of the 1 field or a frame, and drives the scanning electrode 11 alternatively one by one. Drive timing is determined by the timing pulse which the timing-control circuit 18 which operates synchronizing with a vertical synchronizing signal VSYNC generates.
[0055] Next, with reference to drawing 1 , the luminance-signal amendment section 19 which is the feature portion of this invention is explained. As shown in drawing 1 , the luminance-signal amendment section 19 consists of the luminescence (subfield SF) determination section 21 which determines a luminescence subfield, and the luminescence

(subfield SF) storage section 22 which memorizes the luminescence subfield in a front frame.
[0056] The luminescence subfield storage section 22 consists of memory 23 and a memory control section 24 which controls the I/O.
[0057] The luminescence subfield determination section 21 reads and possesses the exclusive memory (ROM) 25, and in order to generate the brightness of the request given to this by the luminance signal, the data in which it is shown which subfield should be made to emit light are beforehand memorized as a table according to the subfield luminescence pattern in a front frame. The data about this subfield that should be made to emit light survey a relation with the brightness beforehand perceived a luminescence pattern to target PDP and subfield arrangement, and determine it based on this survey data. When a relation with the brightness perceived a luminescence pattern is called for by calculation, you may create this table by calculation.
[0058] Arrangement in the frame of the subfield used by this example is shown in drawing 2 . Each subfield consists of the scanning interval and maintenance conducting period for a pre-discharge and write-in electric discharge. Here, as for SF1-SF5, and SF8, weighting is respectively made brightness 1, 2, 4, 8, 16, and 128. About SF 6-1, SF 6-2 and SF 7-1, and SF 7-2, weighting is made the brightness 16 (SF [6-1], SF 6-2) which divided the weight of brightness 32 and 64 into two equally, respectively, and brightness 32 (SF [7-1], SF 7-2). These subfields are matched with each bit of a 8-bit binary digit, B7, B6, B5, B4 and B3, B-2, and B1 and B0, respectively, and SF8-SF1 are [B7-B0] luminescence or un-emitting light according to 1 or 0, respectively. For example, a binary digit 00011111= 32 corresponds to "luminescence and the other subfield are un-emitting light for SF1-SF5", and a binary digit 11 million= 192 corresponds for "un-emitting light, SF 7-1, SF 7-2, and SF8 to emit [SF1-SF5, SF6-1, and SF 6-2] light." Since the luminance signal of 8-bit 256 gradation is changed into luminescence / pattern non-emitting light of a subfield by this invention according to the above-mentioned correspondence relation as it is when displaying a still picture, this PDP can display the brightness of 256 gradation. In this example, as shown in drawing 2 , SF 7-1, SF 7-2 and SF 6-1, and SF 6-2 are symmetrically arranged on both sides of SF8, respectively, and it is considered so that brightness center-of-gravity position change of the luminescence subfield at the time of a bit **** riser may decrease by this. Consequently, in this example, the device is given so that animation false coutour may be suppressed to some extent by the arrangement of a subfield itself.
[0059] Below, operation of the luminescence subfield determination section 21 is explained. For example, by a certain pixel, subframes SF1-SF5 carry out [that the subfield of luminescence and others did not emit light, and] in a front frame now. This luminescence pattern corresponds to a binary digit 00011111= 31. Moreover, suppose that the luminance signal in the present frame in this pixel is "32." The luminescence subfield determination section reads "31" from the luminescence subfield storage section 22 in the luminescence pattern in a front frame, and this case. This, The luminance signal in the present frame and "32" are made into the address. from ROM25 The binary digit 00100011= 35 corresponding to the desirable luminescence pattern in the present frame, for example, "the subframes [SF / SF and / 6-2] 6-1 and luminescence of SF2 and SF1", is read, and it is sent to PDP / display drive control section. PDP / display drive control section receives this signal, makes the subframes [SF / SF and / 6-2] 6-1, and SF2 and SF1 emit light in this pixel, and suppresses generating of animation false coutour. As opposed to it, when a luminescence pattern [in / a front frame / at "32" / in the luminance signal in the present frame] is also "32", the signal which is in agreement with the luminance signal of the present frame, and 00100000= 32 are read from ROM. That is, like [in the case of displaying a still picture], since the signal which is in agreement with the luminance signal of the present frame is read from ROM when the luminance signal in the present frame is in agreement with SF luminescence pattern (corresponding binary digit) in a front frame, for example, it is displayed as it is. Thus, in this invention, when the same luminance signal inputs, according to the subframe luminescence pattern in a front frame, a different subframe luminescence pattern is chosen in the present frame, and it is displayed.
[0060] Thus, the selected pattern of the luminescence subfield in the present frame is sent to the luminescence subfield storage section, is memorized there, and is used in the case of the luminescence pattern determination in the following frame.
[0061] The cause which animation false coutour produces has different brightness from the brightness for which the time of a non-dense produces, consequently it asks in that luminescence is dense or generating in fact at the time of changes of a frame by the interrelation of the time position which the luminescence subfield in a front frame occupies, and the time position of the luminescence subfield in the present frame. With the conventional technology of a publication, the luminescence subfield for generating the brightness for which it asks with the present frame is determined as JP,9-34401,A with reference to the luminance signal in a front frame. however, since the subfield made to actually emit light in a front frame in this case stopped being necessarily in agreement with the luminance signal in a

front frame, when an amendment was unnecessary, in fact, the amendment was made and it had the trouble that it may be now unacquainted and contradiction will arise Memory was made to memorize the actual luminescence subfield in a front frame by this invention to it, since it had the composition of determining the optimal luminescence subfield in the present frame with reference to it, such contradiction was canceled, and it became possible to aim at suppression of animation false coutour more effectively.
(The 2nd example) Drawing 6 is the block diagram showing the outline of the luminance-signal amendment section 19 in the 2nd example by this invention. The luminance-signal amendment section 19 shown in drawing 6 is the three past (generally M past.). The luminescence subfield storage section 22 which memorizes which subfield each pixel made emit light by crossing M to a positive integer, The luminescence pattern in the frame of the past memorized by this is read. It, It consists of the luminescence subfield determination sections 21 which determine whether the subfield luminescence pattern in the present frame, i.e., which subfield, should be made to emit light from the luminance signal showing the brightness for which it asks with the present frame. The luminescence subfield storage section 22 consists of memory 23 (23-1, 23-2, 23-3) which can memorize the luminescence subfield pattern for three frames in each pixel, and a memory control section 24 which controls I/O of memory. Although the luminescence subfield determination section 21 may be realized using a ROM table like the case of an example 1, this consists of this examples using the three-layer perceptron neural network 26 of 25 inputs and eight outputs.
[0062] Here, the luminescence subfield determination section 21 in this example is explained. First, the desirable luminescence pattern according to the luminance signal in a past luminescence pattern history and the past present frame surveys a relation with the brightness perceived a luminescence pattern to target PDP and subfield arrangement, and determines it beforehand based on this survey data. When a relation with the brightness perceived a luminescence pattern is called for by calculation, you may create this table by calculation. The three-layer perceptron neural network (NN) 26 of 25 inputs and eight outputs is made to have learned the table which gives this luminescence pattern in this example. Although this three-layer perceptron neural network 26 can also be constituted from DSP (chip for digital signal processing) etc., in this example, processing by this three-layer perceptron neural network is realized by the processor (ellipsis on a drawing), and ROM (ellipsis on a drawing) which made data required for processing memorize. Therefore, in the neural network who explains below, an input node, a middle node, an output node, etc. do not exist in practice in this example, but these are the things on the imagination for explaining the procedure of processing by the processor.
[0063] About a three-layer perceptron neural network and the learning method (error back propagation learning method) used by it, detailed description is made by the volume "a neuro computer" (technical Hyoronsha 1989 issue) Nakano ****** and for Kazumoto Iinuma, for example. Here, this three-layer neural network is explained. This consists of an input node layer, a middle node layer, and an output node layer. Moreover, the time arrangement of a subfield used by this example is the same as what was used in the example 1, and it is as being shown in drawing 2 . The rule which writes the luminescence pattern of these subfields in the binary digit of 8 figures is the same as the case of an example 1. The numeric value "1" corresponding to the subfield luminescence pattern of three frames ago or "0" inputs into 1-8 among a three-layer neural network's input nodes. That is, when except [it] does not emit [for example, / SF1 to SF4] light by luminescence three frames ago, a numeric value "1" inputs into nodes 1-4, and a numeric value "0" inputs into nodes 5-8. The numeric value corresponding to the luminescence pattern of one frame ago in the numeric value corresponding to the luminescence pattern of two frames ago inputs into nodes 9-16 similarly at nodes 17-24, respectively. The numeric value showing the brightness (luminance signal in the present frame) for which it asks with the present frame inputs into the input node 25. This neural network has learned the input/output relation beforehand so that a desirable subfield luminescence pattern may be outputted from these inputs. Therefore, the numeric value corresponding to the desirable subfield luminescence pattern in the present frame, "0", or "1" is outputted to the output nodes 1-8 by processing these inputs, respectively. For example, by "0", when an output [in / other output nodes / in the output in the output nodes 1, 3, and 5] is "1", SF1, SF3, and SF5 mean un-emitting light and the thing for which other subfields should display a luminescence pattern called luminescence.
[0064] Operation of this neural network is as follows. If a numeric value inputs into an input node, the j-th middle node will perform processing expressed in the following formula as the input to the i-th input node Ii based on the weighting factor Wji learned beforehand and offset thetaj, and will send the result to an output node.
[0065]
[Equation 1]
$$H_j = f\left(\sum_i W_{ji} I_i + \theta_j\right)$$

Function f (x) makes u0 an adjustment parameter, and is [0066] here.
[Equation 2]
$f(x)=1/\{1+\exp(-2x/u0)\}$
It comes out and is the sigmoid function with which it is expressed.
[0067] Next, too, based on the output Hj of each middle node, and weighting-factor Vkj and offset gammak beforehand determined by study, each output node performs processing expressed with the following formula, and outputs the result beforehand.
[0068]
[Equation 3]

$$O_k = f\left(\sum_j V_{kj} H_j + \gamma_k\right)$$

The weighting factor which each middle node and an output node use, Wji and Vkj, an offset value and thetaj, and gammak are beforehand determined based on the following error back propagation learning method, and ROM is made to memorize them in the above processing, so that a neural network may take out a desirable output according to an input. The algorithm of this error back propagation learning method is indicated in detail by the volume "a neuro computer" (technical Hyoronsha 1989 issue) the above-mentioned reference, Nakano ******, and for Kazumoto Iinuma etc., for example. That is, suitable initial value is left to each weighting factor, and an error with the desirable output Tk beforehand determined as the output Ok of each output node of a neural network based on the following formula repeats correction of each weighting factor until it comes to be settled in a setting tolerance.
[0069]
[Equation 4]

$$V_{kj} \Leftarrow V_{kj} + \alpha \delta_k H_j$$

$$\gamma_k \Leftarrow \gamma_k + \beta \delta_k$$

$$W_{ji} \Leftarrow W_{ji} + \alpha \sigma_j I_i$$

$$\theta_j \Leftarrow \theta_j + \beta \sigma_j$$

alpha and beta are suitable constants here and "error" deltak and sigmaj are [0070], respectively.
[Equation 5]

$$\delta_k = (O_k - T_k)\, O_k\, (1 - O_k)$$

$$\sigma_j = \sum_k \delta_k V_{kj} H_j\, (1 - H_j)$$

It is come out and given.
[0071] It is also possible to write the relation between the input to the luminescence subfield determination section 21 and an output in ROM as a look-up table like [in the case of an example 1] here. However, since it becomes that what is necessary is just to make only the weighting factor which each node uses, and the offset value memorize instead of making the table of all input/output relation memorize by using a neural network for this portion like this example, it becomes possible to cut down required storage capacity sharply. The reason such whose storage capacity curtailment is attained is because the table showing the above-mentioned input/output relation is a table redundant [of what is necessary being to add no amendment to almost all inputs, but just to output as it is in fact, etc.]. The effective thing is known, when a neural network can learn the redundancy which is inherent in input/output relation, consequently required storage capacity is cut down. By this invention, storage capacity required for storage of an input/output relation table is compressed using this property.
[0072] Although this neural network can also be constituted from DSP etc., at this example, this consists of a ROM which recorded the weighting factor of each node beforehand determined by study, and a processor which performs a sum-of-products operation and the nonlinear operation by function f (x) one by one using it, and calculates an output.
[0073] Like the case of the 1st example, the subfield luminescence pattern changed in the luminance-signal amendment section 19 is sent to PDP / display mechanical component 20, and emits light in each pixel of PDP. Moreover, this luminescence pattern is sent also to the luminescence subfield storage section 22 as a subframe luminescence pattern of one frame ago, and is referred to in the case of the luminescence subfield determination after the following frame.

[0074] In addition, although it memorized which subfield each pixel made emit light over the three past and the optimal subfield luminescence pattern in the present frame was determined in this example according to it In addition, it is also possible to make it the composition which determines the optimal luminescence subfield in the present frame, after it forms the brightness storage section 27 in the luminance-signal amendment section 19, and also memorizing the luminance signal in the past frame collectively and also taking this into consideration further, as shown in drawing 7 . By making it such composition, the determination of the luminescence subfield which also took into consideration time change of the past of the brightness for which it asks is attained, and a finer brightness amendment is attained. In addition, in drawing 7 , the luminescence subfield determination section 21 is too constituted using the three-layer perceptron neural network. In this case, in addition to the luminance signal in the subfield luminescence pattern in the frame of the past memorized by the luminescence subfield storage section 22, and the present frame inputted from the outside, the luminance signal in the frame of the past memorized by the brightness storage section 27 inputs into an input node collectively, and the optimal luminescence subfield determined beforehand is further outputted to it based on them.

[0075] In addition, although the number of the subfield luminescence patterns in the frame of the past to memorize (frame number) and the number of the luminance signals of the past to memorize (frame number) are the same in drawing 7 , the numbers may differ.

(The 3rd example) Drawing 8 is the block diagram showing the outline of the luminance-signal amendment section 19 in the 3rd example by this invention. In drawing 8 , the brightness pair read-out section 28 takes out serially the luminance signal in 2 pixels which adjoins along with a scan line, and sends it to the luminescence subfield determination section 21. Moreover, this brightness pair read-out section 28 generates the parity signal with which the scan line takes the value of 1 or 0 according to the even-numbered line or the odd-numbered line whenever a new scan line starts, and sends it to the luminescence subfield determination section 21 too. The luminescence subfield storage section 22 has memorized the actual luminescence subfield in a front frame above-mentioned every 2 pixels. This luminescence subfield storage section 22 consists of memory and a memory control section like the case of the 1st example (ellipsis on a drawing).

[0076] Here, the data format in the luminescence subfield storage section 22 in this example is explained. First, also in this example, time arrangement of a subfield is the same as what was used in the example 1, and it is as being shown in drawing 2 . By one pixel, luminescence and other subfields carry out [SF1; SF2, SF 6-1, and SF 6-2 / that luminescence and other subfields did not emit / SF1, SF3, SF 6-1, and SF 6-2 / light by another pixel by un-emitting light, and] between 2 pixels made into the object in now, for example, a front frame. In this case, 00200112= 500 ternaries of 8 figures are memorized by the luminescence subfield storage section 22. That is, the pattern of a luminescence subfield is matched with the number of ternaries of 8 figures, and in this number of ternaries of 8 figures, when a certain digit, for example, the 1st digit, is 2 or 0, also in any, it is shown luminescence (when it is 2) or that target SF1 was not emitting [2-pixel] light (when it is 0). About the 6th figure and the 7th figure, when the number of these digits is 2 or 0, it also sets to which pixel, and it is SF 6-1. SF 6-2 (in the case of the 6th figure) or SF 7-1, and SF 7-2 (in the case of the 7th figure) show luminescence (in the case of 2), or that light was not emitted (in the case of 0). Moreover, when a certain digit, for example, the 2nd digit, is 1, in the subfield corresponding to this digit, and now, these 2-pixel either shows that SF2 was emitting light.

[0077] The luminescence subfield determination section 21 determines the optimal subfield luminescence pattern which comes out [above-mentioned / in the present frame] 2 pixels, respectively based on the luminescence pattern of the subfield in a front frame read from these signals 22, i.e., the luminescence subfield storage section, and the luminance signal in the present frame inputted from the brightness pair read-out section 28.

[0078] Here, with reference to drawing 9 , operation of this luminescence subfield determination section 21 is explained. First, the brightness which should be displayed on the average as a whole 2 pixels is calculated by the luminance signal in the 2 above-mentioned pixels present frame inputted from the brightness pair read-out section 28 being added, and this is sent to the luminescence subfield read-out section 29. The luminescence subfield read-out section 29 possesses ROM25, and the table for determining 2 pixels of which subfields should be made to emit light as a whole as this ROM25 according to a these [in a front frame] 2 pixels subfield luminescence pattern, in order to generate the brightness for which it asks as a whole 2 pixels is memorized beforehand. The data about this subfield that should be made to emit light survey a relation with the brightness beforehand perceived a luminescence pattern to target PDP and subfield arrangement, and determine it based on this survey data. When a relation with the brightness perceived a luminescence pattern is called for by calculation, you may create this table by calculation. The data read from ROM25 are expressed with the number of ternaries of 8 figures like the rule in the luminescence subfield storage

section 22 mentioned above according to the following rules. That is, first, when SF1 should be made to emit [in / any / 2 pixels / above-mentioned] light, the 1st digit is set to 2. Moreover, the 1st digit is set to 0 when not making SF1 emit light also in which pixel. Moreover, SF1 is made to emit light by one of pixels, and in the pixel of another side, when [SF1] un-emitting light, the 1st digit is set to 1. For example, when the data read from ROM25 are 01022100= 954 ternaries, what, as for luminescence, and SF4 and SF5, any pixel should presuppose un-emitting light to SF 7-1, SF 7-2, and SF3 for about the subfield of which pixel or luminescence, and others by one of pixels is meant. The data read from ROM25 are sent to the luminescence subfield storage section 22, and are used for the determination of the optimal luminescence subfield pattern in the following frame. Furthermore, this data is sent also to the luminescence subfield distribution section 30. The luminescence subfield distribution section 30 distributes [above-mentioned] the 2 pixels of the above-mentioned data read from ROM25 to each based on the above-mentioned luminance signal [in / each / 2 pixels], and the parity signal inputted from the brightness pair read-out section 28, and decides the subfield which should be made to emit light in each pixel.

[0079] Operation of this luminescence subfield distribution section 30 is explained. In the luminescence subfield distribution section 30, distribution of a luminescence subfield is performed by the logical circuit according to the following rules. First, as explained above, about the subfield corresponding to the digit from which the number is 0 or 2, also in which pixel, the subfield serves as un-emitting light or luminescence, and luminescence of each pixel and un-emitting light are determined as a meaning in the data of the number of ternaries read from ROM25. To it, in the above-mentioned number of ternaries, when the number of a certain digit is 1, the flexibility about whether the subfield corresponding to the digit should be made to emit light by which pixel remains. That is, for example, when the data read from ROM25 are 01022100= 953 ternaries, as possible distribution, there may be four kinds of B1=01011100=92, B-2=00011000=24, B1=01011000=88 and B-2=00011100=28 or B1=00011100=28, B-2=01011000=88 or B1=00011000=24, and B-2=01011100=92 of cases. In this case, the luminescence subfield distribution section 30 performs distribution of a luminescence subfield according to the following rules. The luminance signal in 2 pixels which has been applicable here is set with A1 and A2, respectively. however, a scan line top -- already -- the luminance signal of a pixel located in A1 and right-hand side in the luminance signal of a pixel located in left-hand side to the pixel of the method of one is set to A2 Moreover, it considers as the binary digit showing the luminescence subfield pattern in each pixel corresponding to possible distribution of a luminescence subfield for B1 and B-2. For example, in a pixel 1, SF3, SF4, and SF5 are luminescence, and when [other subfields] un-emitting light, B1 is 00011100= 28.

[0080] The luminescence subfield distribution section 30 determines first that it is most set to A1 and A2 by B1 and B-2 closely, respectively. Namely, the following formula [0081]

[Equation 6] | Ask for the possible division which makes A1-B1|+|A2-B-2| the minimum. Although processing is ended when this is determined as a meaning, when two or more division which fulfills this condition exists, B1 and B-2 determine in them what becomes as equal as possible. That is, next, it is [0082] in them.

[Equation 7] | Ask for the division which makes B1-B-2| the minimum. Processing is ended when division is determined now as a meaning. When the luminance signal in 2 pixels made into an object, and A1 and A2 are equal to the last, the flexibility of to which pixel to assign B1 or B-2 remains. In this case, a parity signal responds to 0 or 1 and it is B1-A1>B-2-A2. (when a parity signal is 0)

B1-A1<B-2-A2 (when a parity signal is 1)

A subfield is distributed according to the rule to say. That is, the present scan line changes whether the 1st pixel of the above-mentioned pixel pair is more brightly displayed compared with a luminance signal, or it displays more darkly according to even lines or odd lines. Consequently, as shown in drawing 16 , the pixel displayed more brightly and the pixel displayed more darkly will be arranged in the shape of a checker board on a screen, and there is an effect to which it is not conspicuous as the whole and the brightness error produced for every pixel is carried out.

[0083] Thus, it is able to arrange on a screen the pixel more brightly displayed even if it is the case in which a then perfect brightness amendment is impossible for every pixel, and the pixel displayed more darkly in the shape of a checker board, to generate desired average brightness as the whole, and to suppress animation false coutour in this invention.

[0084] The luminescence subfield distribution section 30 outputs the luminescence pattern signal in the above-mentioned 2 pixels determined in this way, B1, and B-2 to this turn. Like the case of an example 1, the subfield luminescence pattern determined in the luminance-signal amendment section 19 is sent to PDP / display mechanical component, and emits light in each pixel of PDP.

[0085] In addition, in this example, although the optimal luminescence subfield is determined according to the luminescence pattern in a front frame every 2 pixels, the luminescence pattern in two or more past frames is

memorized, and it is also possible to make it the composition which determines the optimal luminescence subfield in the present frame with reference to these. In this case, in the luminescence subfield determination section, when determining the optimal luminescence subfield cuts down required storage capacity using the same three-layer neural network as the thing stated in the example 2 instead of a ROM table, it is desirable. Furthermore, as shown in drawing 10 , it is also possible to make it the composition which also memorizes the luminance signal in two or more past frames by the brightness storage section 27, and determines the optimal luminescence subfield in the present frame in the luminescence subfield determination section 19 further by the luminescence subfield storage section 22 according to these while memorizing the luminescence pattern in two or more past frames. Although a required frame memory and the storage capacity which is needed in the luminescence subfield determination section increase by this, a finer brightness amendment is attained.

[0086] In addition, although the number of the subfield luminescence patterns in the frame of the past to memorize (frame number) and the number of the luminance signals of the past to memorize (frame number) are the same in drawing 10 , the numbers may differ.

[0087] Moreover, while memorizing the luminescence pattern in a front frame by the luminescence subfield storage section 22, it is also possible to also memorize the luminance signal in a front frame and to make it further, the composition which determines the optimal luminescence subfield in the present frame in the luminescence subfield determination section 19 by the brightness storage section 27, according to these.

[0088] Furthermore, in drawing 10 , it is also possible to make the optimal luminescence subfield in the present frame the composition for which it opts every 2 pixels only with reference to the luminance signal in the frame of the past which omits the luminescence subfield storage section 22 and has been memorized in the brightness storage section 27. Even when this method is taken, since it has the composition of determining the optimal luminescence subfield every 2 pixels which adjoin in this invention compared with the conventional method memorized by JP,9-34401,A, respectively, it is possible to cancel and reduce an amendment error as a whole by 2 pixels, and animation false coutour depressor effect is increasing.

[0089]

[Effect of the Invention] As having explained above, since it has made the composition which determines the actual subfield luminescence pattern in the past frame, and the subfield luminescence pattern which is most suitable with the present frame from the luminance signal in the present frame in this invention, when the luminance signal in the past frame and the subfield luminescence pattern in the past frame do not correspond, a luminance-signal amendment is performed correctly, and there is an effect which heightens animation false-coutour depressor effect remarkably.

[0090] Moreover, it writes in the composition which determines the subfield luminescence pattern which was most suitable with the present frame, the luminance-signal amendment as which not only the last frame but the influence of the luminescence subfield in the frame of two or more frames ago was considered is performed from the luminescence pattern of the subfield in two or more past frames, and the luminance signal in the present frame, and there is an effect which raises the precision of animation false-coutour suppression remarkably in this invention.

[0091] Furthermore, in this invention, it writes in the composition which determines the adjoining optimal luminescence [in / each / 2 pixels per 2 pixels] subfield from the subfield luminescence pattern in the past frame, and the luminance signal in the present frame. Even when amendment sufficient in the amendment processing performed for every pixel like the conventional method is impossible 2 pixels of amendment errors can be made to cancel as a whole, it becomes possible to generate the adjoining brightness for which it asks with an average more sufficient precision, and the effect which heightens animation false coutour depressor effect remarkably is acquired.

[Translation done.]

TECHNICAL FIELD

[The technical field to which invention belongs] Especially this invention relates to the gradation display suitable for the animation false coutour suppression in the gradation display of display, such as a plasma display panel, and the gradation method of presentation about gradation display and the gradation method of presentation.

[Translation done.]

PRIOR ART

[Description of the Prior Art] generally, a plasma display panel (it is hereafter called PDP for short) does not have a flicker with thin shape structure, and it is possible that a display contrast ratio is large and for it to be comparatively alike and to consider as a big screen, a speed of response is quick, and it has many features -- multicolor luminescence is also possible -- by use of a fluorescent substance with the spontaneous light type For this reason, in the field of computer-related display, the field of a color picture display, etc., it is coming to use widely in recent years.
[0003] There are an alternating current electric discharge type thing which an electrode is covered with a dielectric by the method of operation, and is indirectly operated in the state of alternating current electric discharge, and a direct-current-discharge type thing which an electrode is exposed to discharge space and operates in the state of a direct current discharge in this PDP. Furthermore, there are a memory operation type which uses the memory of an electric discharge cell as a drive method, and a refreshment operation type which does not use it as alternating current electric discharge type. In addition, the brightness of PDP is proportional to the number of times of electric discharge, i.e., the number of repeats of a pulse voltage, mostly. In the case of the above-mentioned refresh type, since brightness will fall if display capacity becomes large, it is mainly used to PDP of small display capacity.
[0004] Drawing 11 is a cross section which illustrates the outline of the composition of one display cell of alternating current electric discharge memory operation type PDP. Opposite arrangement of the two insulating substrates (a display side glass substrate, rear-face side glass substrate), the front face where this display cell consists of glass, and a tooth back, 1 and 2 is carried out. On the insulating substrate 1 by the side of opposite, the septum 34 formed on the wrap dielectric layer 4 and the dielectric layer 4 in the transparent scanning electrode 32 and the transparent maintenance electrode 33, and the scanning electrode 32 and the maintenance electrode 33 and the protective layer 36 which consists of the magnesium oxide which protects a dielectric 4 from electric discharge are formed. Moreover, on the insulating substrate 2 by the side of opposite, the data electrode 5 formed by intersecting perpendicularly with the scanning electrode 32 and the maintenance electrode 33 and the fluorescent substance 9 which changes into the light 35 the ultraviolet rays which generate this data electrode 5 by the wrap dielectric layer 7 and electric discharge of a discharge gas are formed.
[0005] The space between an insulating substrate 1 and an insulating substrate 2 is filled up with the discharge gas which consists of those mixed gas, such as helium, neon, and a xenon, the discharge-gas space 37 is formed, and a septum 34 is formed in order to divide a display cell, while securing this discharge-gas space 37.
[0006] Next, with reference to drawing 11 , electric discharge operation of the selected display cell is explained. If the pulse voltage exceeding an electric discharge threshold is impressed between the scanning electrode 32 and the data electrode 5 and electric discharge is made to start, corresponding to the polarity of this pulse voltage, the charge of positive/negative will be attracted by the front face of the dielectrics 4 and 7 of both sides, and will produce deposition of a charge. Since it becomes the above-mentioned pulse voltage and reversed polarity, even if the effective voltage inside a cell falls with growth of electric discharge and the above-mentioned pulse voltage holds constant value, the equivalence internal voltage resulting from deposition of this charge, i.e., wall voltage, cannot maintain electric discharge, but it ****** it at last. Since it is superimposed on the part of wall voltage as an effective voltage when the maintenance pulse which are wall voltage and the pulse voltage of like-pole nature is impressed between the scanning electrodes 32 and the maintenance electrodes 33 which adjoin next, even if the voltage swing of a maintenance pulse is low, it can discharge exceeding an electric discharge threshold.
[0007] Therefore, it becomes possible by continuing impressing a maintenance pulse between the scanning electrode 32 and the maintenance electrode 33 to maintain electric discharge. This function is an above-mentioned memory. Moreover, the scanning electrode 32 or the maintenance electrode 33 can be made to stop the above-mentioned maintenance electric discharge by impressing the elimination pulse which is the pulse of the latus low battery of width

of face which neutralizes wall voltage, or a pulse about [of width of face / narrow] a maintenance pulse voltage.
[0008] Drawing 12 is drawing showing electrode wiring of the line of a jxk individual, and the panel for a dot-matrix display which arranged the display cell in the shape of [which consists of a train] a matrix. It has the scanning electrodes Sc1, Sc2, --, Scj and the maintenance electrodes Su1, Su2, --, Suj which were arranged in parallel as a line electrode, and has the data electrodes D1, D2, --, Dk which intersected perpendicularly with these scanning electrode and the maintenance electrode as a train electrode, and were arranged. A round term of a drive of this panel is written in with a pre-discharge period, consists of a conducting period and a maintenance conducting period, repeats this, and obtains desired graphic display.
[0009] A pre-discharge period impresses the pre-discharge elimination pulse for extinguishing the charge which checks write-in electric discharge and maintenance electric discharge among the wall charges generated by impression of the pre-discharge pulse which it is [pulse] a period for generating an activity particle and a wall charge, and makes all the display cells of the PDP panel discharge simultaneously in discharge-gas space, and a pre-discharge pulse, in order [which was stabilized in the write-in conducting period] to write in and to acquire an electric-discharge property. A maintenance conducting period is a period which maintenance electric discharge is carried out [period] in order to obtain desired brightness, and makes the display cell which discharged by writing in in a write-in conducting period emit light.
[0010] In a pre-discharge period, a pre-discharge pulse is first impressed to the maintenance electrodes Su1, Su2, --, Suj, and electric discharge is caused in all display cells. Then, an elimination pulse is impressed to the scanning electrodes Sc1, Sc2, --, Scj, elimination electric discharge is generated, and the wall charge deposited by the pre-discharge pulse is eliminated.
[0011] Then, it writes in, and in a period, a scanning pulse is impressed to the scanning electrodes Sc1, Sc2, --, Scj line sequential, further, a data pulse is impressed alternatively, and is written in the data electrode Di (1 <=i<=k) in the cell which should be displayed corresponding to graphic display data, electric discharge is generated, and a wall charge is generated.
[0012] Finally in a maintenance conducting period, only the display cell which caused write-in electric discharge causes maintenance electric discharge continuously by the maintenance pulse, and luminescence operation of the 1st page is completed.
[0013] Drawing 13 is made into an example and the subfield display by the scanning maintenance separation drive used used by AC type color plasma display is explained. Although the 1 field is made into about 1/60 second whose flicker is not usually visible, as shown in drawing 13 , this is divided into six subfields of SF6 from the subfield SF 1 which consists of a scanning interval and a conducting period. In the scanning interval of a subfield SF 6, writing is performed to each pixel based on the indicative data of B5 of the most significant bit. After complete writing is completed, a maintenance electric discharge pulse is impressed all over a panel, and only the write-in pixel is indicated by luminescence. Next, the same drive is performed also in a subfield SF 5. In the maintenance conducting period of each subfield, in order to obtain sufficient brightness, 128 times, in SF1, 64, 32, and 16 or 8 times of maintenance electric discharge pulses are impressed, and emit light from a subfield SF 4 256 times by the subfield SF 6 at a subfield SF 5, respectively.
[0014] Although the rapidity which performs a scan in a short time and writing is required in order to have produced adoption of such a subfield method from the need of modulating luminescence brightness in the number of times of luminescence, or a luminescence period and to scan multiple times during the 1 field naturally, improvement in the write-in performance of a plasma display panel is achieved in recent years, writing has become possible and at least three or less microseconds also of full color displays of 256 gradation by eight subfields have also been realized.
[0015] Although a good gradation display is reproduced by such subfield method in the case of a still picture, disturbance occurs with an image in animation display. For example, when the picture from which a luminosity changes smoothly like a person's cheek moves in a screen top, a dark profile, and a bright profile or a different profile of a color appears into the portion of the cheek which should be a picture smooth originally. Moreover, a color gap, the feeling of a fall of resolution, etc. are brought about. Such animation false coutour is very conspicuous on the boundary which advances to a high order bit in a smooth gradation change, and has the problem which spoils display grace and quality of image remarkably.
[0016] Drawing 14 shows a part of gradation realized with the combination of eight subfields SF8-SF1 by which weighting was carried out to the 8-bit binary digit B7, B6, B5, B4 and B3, B-2, and the brightness 128, 64, 32, 16, 8, 4, 2, and 1 respectively corresponding to B1 and B0. The display of 256 gradation is attained by combining these subfields. That is, the brightness of 256 gradation of each pixel can be expressed in the 8-bit binary digit of B7-B0. It

becomes the natural picture which was made to display a picture one by one by the subfields SF8-SF1 which expressed the existence of brightness 128, 64, 32, 16, 8, 4, 2, and 1 in a binary digit B7-B0, and was expressed by the visual storage effect by halftone.

[0017] In drawing 14 , when one gradation changes from brightness 127 to especially the brightness 128, all the values of all of B6-B0 change from "1" to "0" a lot, and B7 changes to "1" from "0." For this reason, supposing it makes light emit by the time order of the subfield SF 8 of the most significant from the subfield SF 1 of the least significant, a luminescence period will change from the first portion of the field to the section remarkably in the second half, consequently animation false coutour will occur.

[0018] Some methods are proposed in order to solve this problem. the Institute of Electronics and Communication Engineers paper magazine -- in Mr. Takigawa's paper "TV display by AC plasma panel" indicated from 56 pages to 62 pages of '77/VolJ60-ANo.1 A bit winds [the center-of-gravity position of brightness within a time / of the 1 field]. wind, and a riser and before and after falling It is supposed that it is effective to arrange a subfield so that it may not move as much as possible, and the subfield array of SF3, SF4, SF5, SF1, and SF2 which allotted the luminescence period of a high order bit to the center section in the example of 5 bits, i.e., 32 gradation displays, is effective in suppression of animation false coutour. Moreover, it is also effective to decrease the display time in 1 field, in the example of an experiment, by shortening a display period at the time of the quadrant of the 1 field, it combines with the above-mentioned subfield array, and the good display is realized.

[0019] moreover, in the paper "the middle means of displaying of television using the memory type discharge-in-gases panel" of Mr. Konoue of EID 90-9 of the electronic-intelligence communication society technical report reported in 1990 The time interval from the bit of the beginning of the field to the bit of the last of the next field It is supposed that animation false coutour will be improvable by considering as less than 20 mses which are the critical fusion frequency of human being's visual sense. Like above-mentioned Mr. Takigawa's method, a subfield cannot be arranged over the whole 1 field, but it can consider as less than 20 mses by stuffing one side, and it is supposed that animation false coutour will be improved.

[0020] Moreover, it is supposed also by dividing and arranging the bit of a high order with a long luminescence period that this condition can be fulfilled. In a 8-bit display, are divided B7 of a high order into SF 8-1 and SF 8-2, and B6 is divided into two at SF 7-1 and SF 7-2, respectively. By arranging the 1 field with 10 subfield composition in order of SF 7-1 and SF 8-1 which have arranged dispersedly the subfield divided respectively, SF1, SF2, SF3, SF4, SF5, SF6 and SF 7-2, and SF 8-2 Time from the bit of the beginning of the field to the bit of the last of the next field can be made into 18.8 mses, and it is reported that the gradation disorder of an animation has been improved.

[0021] in addition, although the most significant bit of a binary digit which expresses the weight of brightness with the above-mentioned paper is set to B1 and the subfield of the most significant corresponding to it is set to SF1, in this invention, it unifies into expression generally used in the information processing field, and the subfield of Bn-1 and the least significant is expressed [a least significant bit] for B0 and the most significant bit of n figures as SF1

[0022] As the above optimization of a subfield array, shortening of field time or a luminescence display period, or methods other than the method of dividing the long subfield of a luminescence period, an amendment is added to a status signal and the method of suppressing animation false coutour is learned by making a subfield without a lighting schedule turn on, or making the subfield of a lighting schedule switch off conversely. In JP,8-54853,A, an animation false coutour field (the fake image field is indicated by JP,8-54853,A) is detected, it distinguishes to it whether the brightness of this animation false coutour field is brighter than original brightness, and the idea of controlling luminescence of the pixel of this field based on this distinction result is indicated. Furthermore, an animation lost-motion vector is detected to JP,8-123355,A and JP,8-211848,A, and the method of controlling luminescence of a pixel to suppress the animation false coutour generating is expected to be using it is indicated. The bit produced by brightness change winds in JP,9-102921,A, a riser is detected in each pixel to it, and the method of rectifying an indicative data based on the result is indicated. Moreover, the method of asking JP,9-34401,A for the amendment signal for suppressing animation false coutour beforehand, reading this as a look-up table, and writing in exclusive memory (ROM) is indicated.

[0023] Drawing 15 is the block diagram showing the signal amendment method indicated by JP,9-34401,A. In case it rectifies by this method, the frame memory is made to memorize the luminance signal of the past frame, an amendment signal is read from ROM by making this and the luminance signal in the present frame into the address, this is added to the luminance signal in the present frame, and it sends to the drive control circuit of PDP. The amendment data for suppressing animation false coutour which ROM should be made to memorize beforehand here are decided based on survey data.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since it is made the composition which determines the actual subfield luminescence pattern in the past frame, and the subfield luminescence pattern which was most suitable with the present frame from the luminance signal in the present frame in this invention as explained above, When the luminance signal in the past frame and the subfield luminescence pattern in the past frame do not correspond, a luminance-signal amendment is performed correctly, and there is an effect which heightens animation false coutour depressor effect remarkably.
[0090] Moreover, it writes in the composition which determines the subfield luminescence pattern which was most suitable with the present frame, the luminance-signal amendment as which not only the last frame but the influence of the luminescence subfield in the frame of two or more frames ago was considered is performed from the luminescence pattern of the subfield in two or more past frames, and the luminance signal in the present frame, and there is an effect which raises the precision of animation false-coutour suppression remarkably in this invention.
[0091] Furthermore, in this invention, it writes in the composition which determines the adjoining optimal luminescence [in / each / 2 pixels per 2 pixels] subfield from the subfield luminescence pattern in the past frame, and the luminance signal in the present frame. Even when amendment sufficient in the amendment processing performed for every pixel like the conventional method is impossible, 2 pixels of amendment errors can be made to cancel as a whole, it becomes possible to generate the adjoining brightness for which it asks with an average more sufficient precision, and the effect which heightens animation false coutour depressor effect remarkably is acquired.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the above conventional technology, animation false coutour is not fully suppressed and, still, the method by optimization of the order of a subfield does not have it to high-definition graphic display. [enough] Moreover, by the method of dividing shortening of field time, shortening of a luminescence display period, or many subfields, in order to demonstrate the depressor effect of sufficient animation false coutour, it is necessary to shorten a scanning interval considerably. Although this can respond in the plasma display with a small display capacity by which shortening of a scanning interval is permitted, animation display of many gradation is rather desired on the big display of display capacity, and it becomes difficult to shorten a scan time still more sharply and to drive it in this case.
[0025] By working effectively, even if many subfields are not used for the method of suppressing animation false coutour by signal amendment, at this point, although it is advantageous, it is hard to say that the load of movement detection processing is large and the method of detecting the motion vector of an animation and controlling luminescence of a pixel is practical at present.
[0026] Then, although a method of performing a signal amendment, without performing movement detection processing was desired, in this case, by the Prior art, animation false coutour could not fully suppress in fact, but there was a trouble that it was still inadequate, to high-definition graphic display too.
[0027] Analysis of this reason mentions the point of having determined the amendment signal in the present frame using the luminance signal in the past frame, with the conventional signal amendment technology as the 1st trouble. For For example, when luminescence brightness changes to 31 from 32 in subfield arrangement of drawing 13 , time to change in the state where SF6 quenches and SF1-SF5 are emitting light, consequently for luminescence become a non-dense from the state where only SF6 is emitting light, at the time of changes of a frame arises, for this reason, a screen becomes dark for a moment, and animation false coutour occurs. An amendment signal (for example, +10) is added for this to an amendment sake at the luminance signal in the present frame, and brightness 41 is displayed. However, with the following frame, since having considered the case where you want to generate brightness 41 with the following frame here the pixel displayed brightness 41 in fact with the present frame, although an amendment is unnecessary **** Since the luminance signal from the first in the present frame was 31, by the conventional method, the contradiction in which an amendment signal (for example, -7) when a luminance signal changes to 41 from 31 will be read, and it will be added had happened.
[0028] Although the brightness which not only the luminescence state in the last frame but the luminescence state of two or more frames ago is perceived with the present frame is affected in fact as the 2nd trouble, by the conventional method, this point is not taken into consideration but the point of having determined the amendment signal only from the luminance signal in the present frame and the luminance signal of one frame ago is mentioned. For this reason, a high amendment of precision was not completed by the conventional method.
[0029] Although the signal amendment was performed for every pixel by the conventional method as the 3rd trouble, no matter what amendment it may perform then for every pixel in fact, the point that sufficient amendment may be unrealizable is mentioned.
[0030] (The purpose of invention) this invention aims at offering the gradation display and the gradation method of presentation which suppress disturbance of animation false coutour remarkably in view of the above-mentioned technical problem.

[Translation done.]

MEANS

[Means for Solving the Problem] In the gradation display which the gradation display of this invention divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The subfield luminescence history of the past memorized by this luminescence subfield storage means, It is the gradation display characterized by having a luminescence subfield determination means to determine the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.
[0032] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, A luminance-signal storage means to memorize the luminance signal in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The subfield luminescence history of the past memorized by this luminescence subfield storage means and this luminance-signal storage means, and the history of the past luminance signal, It is the gradation display characterized by having a luminescence subfield determination means to determine the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.
[0033] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It has a luminescence subfield determination means to determine the luminescence subfield in the present frame. the aforementioned luminescence subfield determination means The subfield luminescence pattern in the frame of the past in adjoining L pixels (L is the two or more natural numbers) is read from the aforementioned luminescence subfield storage means. From this subfield luminescence pattern and the luminance signal in the present frame in the aforementioned L pixels It is the gradation display characterized by being a means to determine the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame to each aforementioned L pixel.
[0034] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. It has a luminance-signal storage means to memorize the luminance signal in a front frame, and a luminescence subfield determination means to determine the luminescence subfield in the present frame. The aforementioned luminescence subfield determination means the luminance signal in the front frame in adjoining L pixels (L is the two or more natural numbers) Read from the aforementioned luminance-signal storage means, and from this and the luminance signal in the present frame in the aforementioned L pixels It is the gradation display characterized by being a means to determine the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame to each aforementioned L pixel.
[0035] Moreover, the gradation display of this invention divides 1 field period into two or more subfields, and sets it to the gradation display which displays gradation with the combination of the subfield. A luminescence subfield storage means to memorize the luminescence subfield in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, A luminance-signal storage means to memorize the luminance signal in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It has a luminescence subfield determination means to determine the luminescence subfield in the present frame. the aforementioned luminescence subfield determination means The subfield luminescence pattern history in the frame of

the past in adjoining L pixels (L is the two or more natural numbers), The luminance-signal history in the frame of the past in the aforementioned L pixels, respectively The aforementioned luminescence subfield storage means, And read from a luminance-signal storage means and it sets on the present frame from these and the luminance signal in the present frame in the aforementioned L pixels. It is the gradation display characterized by being a means to determine the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole to each aforementioned L pixel.

[0036] In the gradation method of presentation which the gradation method of presentation of this invention divides 1 field period into two or more subfields, and displays gradation with the combination of the subfield The luminescence subfield luminescence history in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.

[0037] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The subfield luminescence history of the past in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, The history of the luminance signal of the past in the frame of the past which consists of a front frame or a front frame, and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield which is suitable for generating desired brightness in the present frame from the luminance signal in the present frame.

[0038] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The subfield luminescence pattern in the frame of the past which consists of the front frame or front frame in adjoining L pixels (L is the two or more natural numbers), and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.

[0039] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The luminance signal in the front frame in adjoining L pixels (L is the two or more natural numbers), It is the gradation method of presentation characterized by determining the combination of the luminescence subfield suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.

[0040] Moreover, the gradation method of presentation of this invention divides 1 field period into two or more subfields, and sets it to the gradation method of presentation which displays gradation with the combination of the subfield. The subfield luminescence pattern history in the frame of the past which consists of at least one frame before the front frame or the front frame, and this front frame in adjoining L pixels (L is the two or more natural numbers), The luminance-signal history in the frame of the past which consists of the front frame in the aforementioned L pixels or a front frame, and at least one frame before this front frame, It is the gradation method of presentation characterized by determining the combination of the luminescence subfield which is suitable for aforementioned generating L pixels of desired average brightness as a whole in the present frame from the luminance signal in the present frame in the aforementioned L pixels to each aforementioned L pixel.

[Translation done.]

OPERATION

(Operation) Although the luminescence pattern of the subfield in the past frame which is suitable for the present frame from a luminance signal from the first and the luminance signal of the present frame was determined by the already explained signal amendment method of drawing 15 In this invention, it is not a luminance signal from the first in the past frame. The signal which rectified to the luminance signal, i.e., the signal showing the subfield made to actually emit light, is memorized in the luminescence subfield storage section. the luminescence subfield determination section This signal (signal showing the subfield made to actually emit light), A desirable amendment is determined from the luminance signal in the present frame, and the luminescence pattern of a subfield which was most suitable with the present frame is determined.
[0042] When the input luminance signal in the past frame differs from the signal made to actually emit light, the contradiction of the conventional method that an amendment will be performed based on a different input luminance signal from the thing made to actually emit light is canceled by this, and remarkable animation false coutour depressor effect can be realized by it.
[0043] Moreover, in this invention, the luminescence subfield storage section which has two or more frame memories is made to memorize the subfield luminescence pattern in two or more past frames, and the luminescence subfield determination section determines the subfield luminescence pattern which was most suitable with the present frame from the subfield luminescence pattern of these past, and the luminance signal in the present frame. Consequently, according to the time change history of an input luminance signal, the signal amendment as which not only the luminescence subfield in the last frame but the influence of the luminescence subfield in the frame of two or more frames ago was considered, and the determination of a luminescence subfield are attained, and a high amendment of precision can be realized more.
[0044] Furthermore, 2 pixels which the luminescence subframe storage section is made to memorize the subfield luminescence pattern in the past frame, and adjoins in this invention (generally L pixels.) The luminescence subfield determination section determines which subfield should be made to emit [in / each / 2 pixels / above-mentioned] light with the luminescence subfield of the past / in / two or more positive integers / in L], and a 2 above-mentioned pixels / in the present frame / luminance signal to the present frame. Even when amendment sufficient in the amendment processing performed for every pixel like the conventional method is impossible, 2 pixels of amendment errors are made to cancel as a whole, it becomes possible to generate the adjoining brightness for which it asks on the average with a more sufficient precision, and the depressor effect of remarkable animation false coutour is obtained by this. It is as follows when supplemented with why this becomes possible. If the number of the subfields arranged all over 1 field is set to n, the number of the luminescence states which each pixel can take in the 1 field will become as the n-th power of 2 in general. By the method of performing a brightness amendment for every pixel, you have to choose the optimal luminescence state out of these states where it was restricted. When generating the brightness for which it asks on the average as a whole 2 pixels as opposed to it, the luminescence state more optimal out of many possible luminescence states can be chosen. In this case, since "it is un-emitting light 2 pixels", "2 pixels emitting light", and three kinds of "only one of pixels emit light" exist for every subfield, a possible luminescence state can choose the luminescence state optimal out of the possible luminescence state as the n-th power of 3 as the whole. Therefore, since the optimal luminescence state can be chosen from more luminescence states by performing a signal amendment per 2 pixels in this way, it becomes possible to generate the average brightness for which it asks with a more sufficient precision.

[Translation done.]

EXAMPLE

[Example] Hereafter, with reference to a drawing, it explains in detail based on the suitable example of this invention.

[Translation done.]

DESCRIPTION OF DRAWINGS

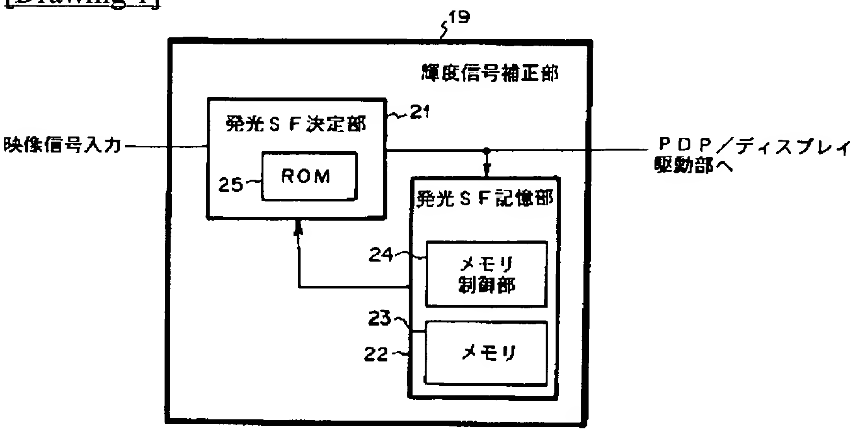
[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the luminance-signal amendment section in the 1st example by this invention.
[Drawing 2] It is the plot plan of a during [the frame time of the subfield used in the example].
[Drawing 3] It is the block diagram showing the outline of this invention.
[Drawing 4] It is the block diagram showing the outline of PDP used in the example of this invention, and a display drive control section.
[Drawing 5] It is the ****** view showing the structure of the plasma display panel (PDP) used for the example of this invention.
[Drawing 6] It is the block diagram showing the luminance-signal amendment section in the 2nd example by this invention.
[Drawing 7] In the 2nd example by this invention, it is the block diagram showing the luminance-signal amendment section at the time of making it the composition which carries out the signal amendment also in consideration of the past luminance signal.
[Drawing 8] It is the block diagram showing the luminance-signal amendment section in the 3rd example by this invention.
[Drawing 9] It is the block diagram showing the luminescence subfield determination section in the luminance-signal amendment section of drawing 8 .
[Drawing 10] In the 3rd example by this invention, it is the block diagram showing the luminance-signal amendment section at the time of making it the composition which carries out the signal amendment also in consideration of the past luminance signal.
[Drawing 11] It is the cross section showing the composition of one display cell of AC memory operation type PDP.
[Drawing 12] It is the plan showing the electrode disposition of AC memory operation type PDP.
[Drawing 13] It is explanatory drawing of the subfield method for the conventional gradation display.
[Drawing 14] It is explanatory drawing of the subfield luminescence pattern for explaining animation false coutour.
[Drawing 15] It is a block diagram explaining the signal amendment method by the conventional technology.
[Drawing 16] In the 3rd example by this invention, it is explanatory drawing which explains the method of arrangement of the pixel displayed more brightly and the pixel displayed more darkly as a result of a signal amendment.
[Description of Notations]
1 2 Insulating substrate
3 Field Discharge Electrode
4 Dielectric Layer
5 Data Electrode
6 Septum (Black)
7 White Dielectric Layer
8 Septum (White)
9 Fluorescent Substance
10 Data Driver
11 Scanning Electrode
12 Scanning Driver
13 Maintenance Electrode
14 Maintenance Driver

15 Driver Control Circuit
16 Frame Memory / Memory Control Section
17 Pretreatment Section
18 Timing-Control Circuit
19 Luminance-Signal Amendment Section
20 PDP / Display Drive Control Section
21 Luminescence Subfield Determination Section
22 Luminescence Subfield Storage Section
23 Memory
24 Memory Control Section
25 Memory Only for Read-out
26 Neural Network Section
27 Brightness Storage Section
28 Brightness Pair Read-out Section
29 Luminescence Subfield Read-out Section
30 Luminescence Subfield Distribution Section

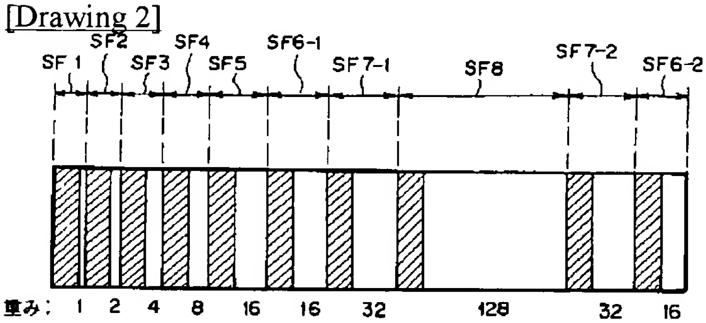
[Translation done.]

DRAWINGS

[Drawing 1]



[Drawing 2]



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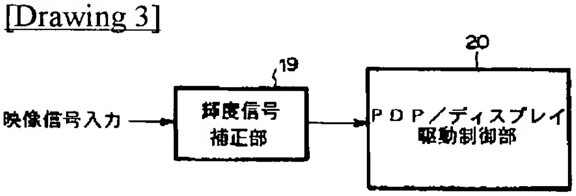
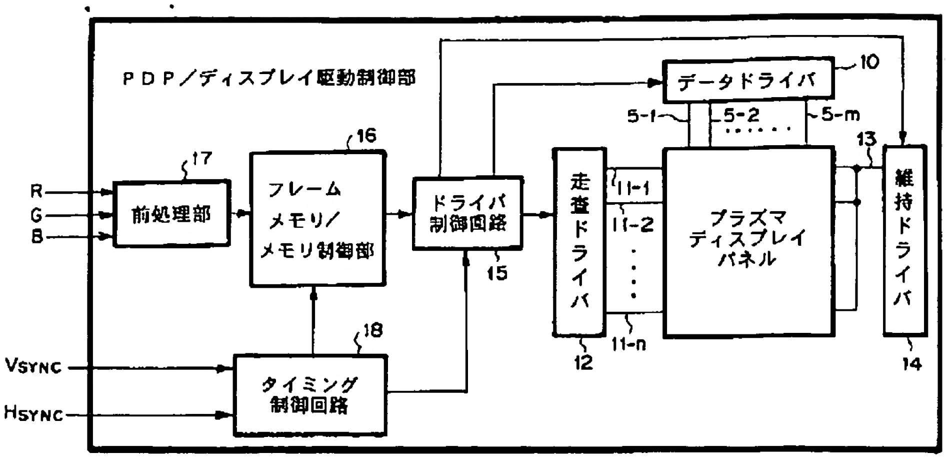


[Drawing 4]



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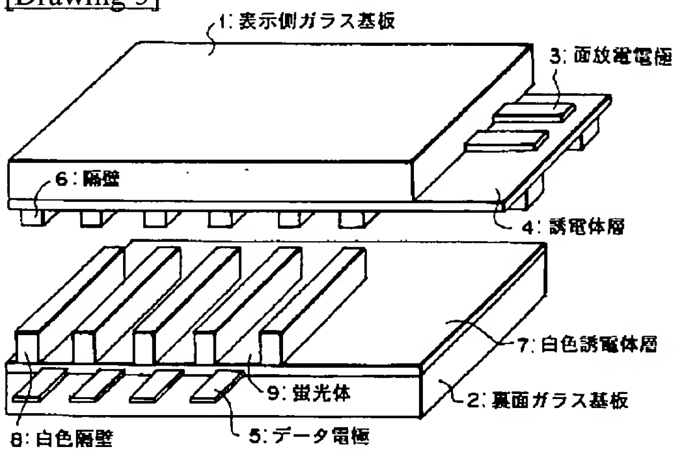
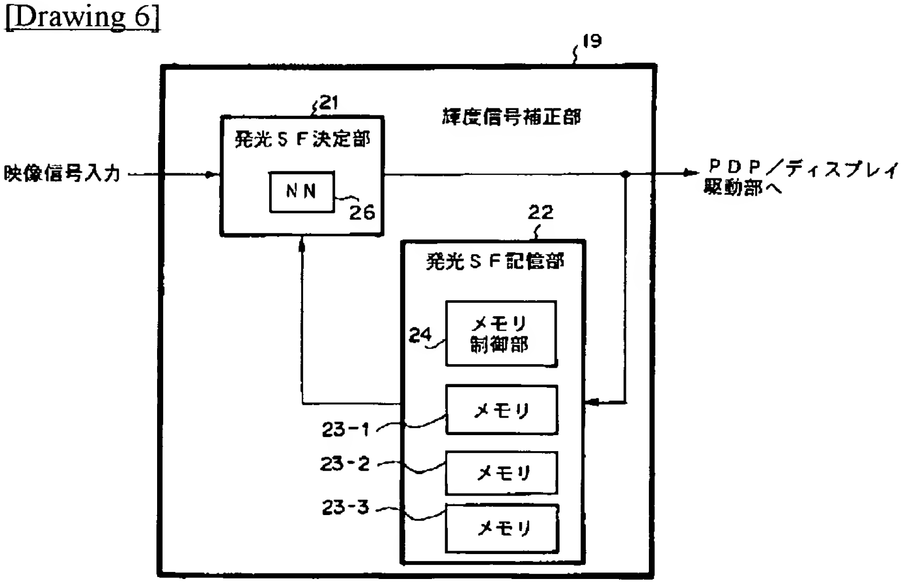


[Drawing 6]



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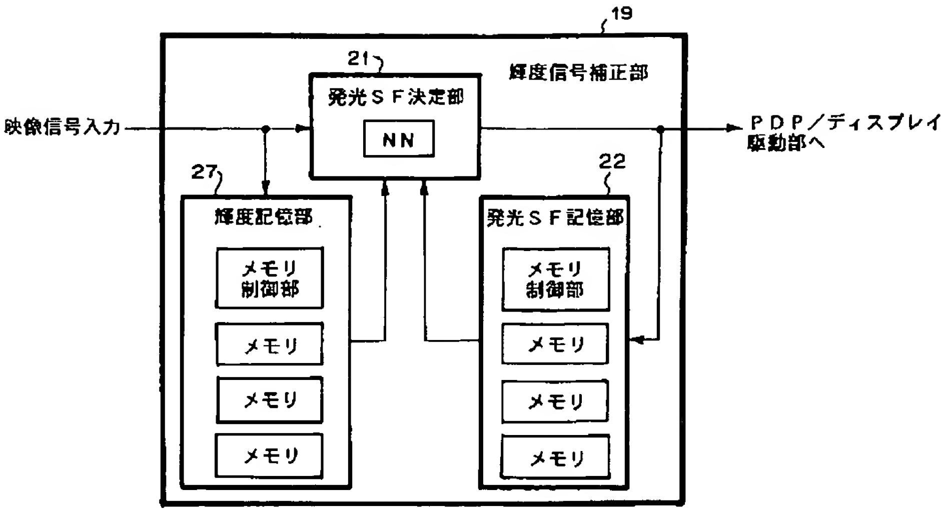
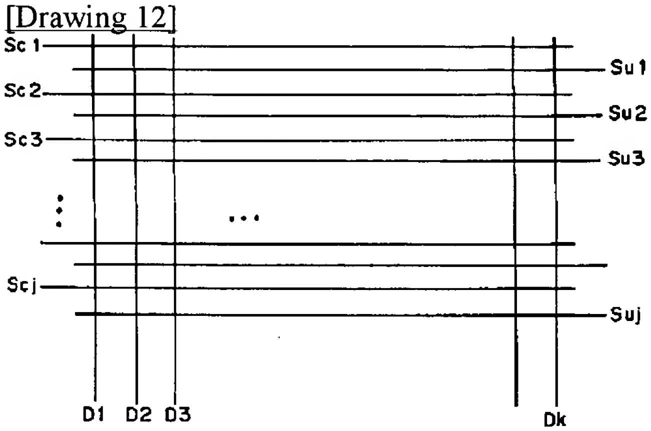
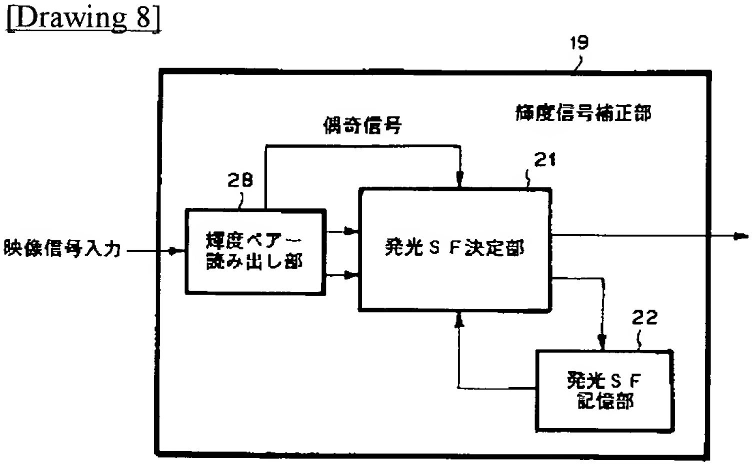


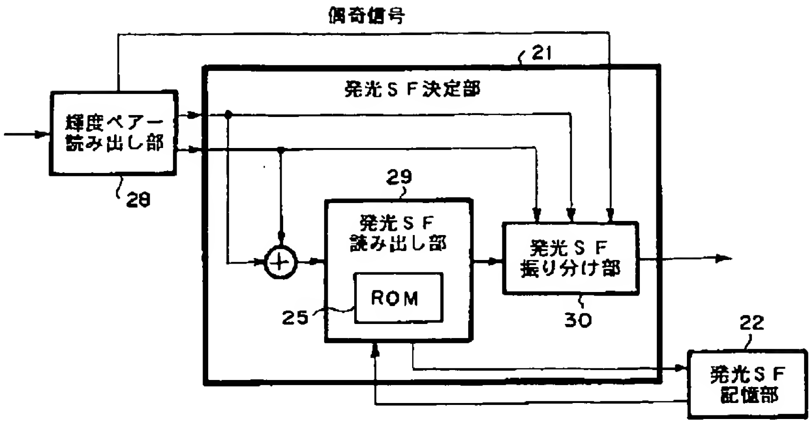
[Drawing 12]



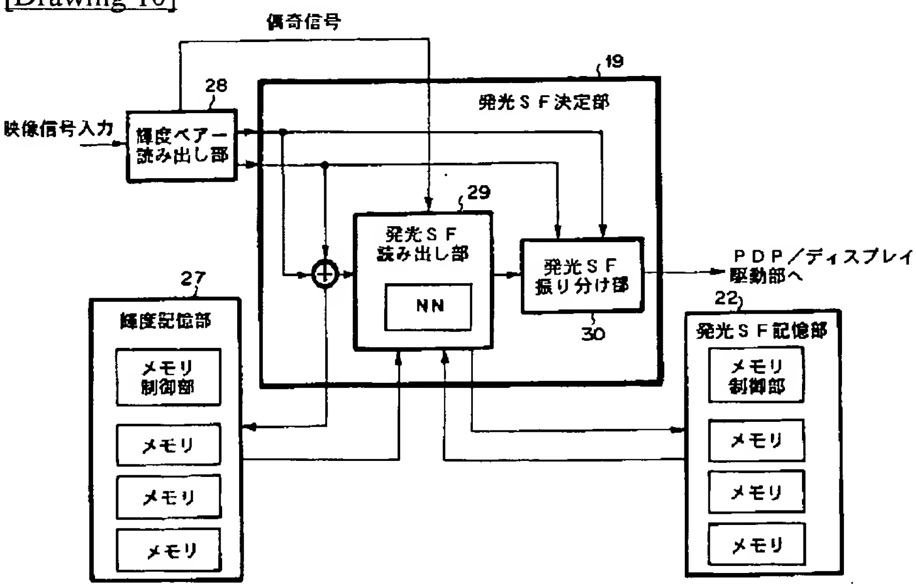
[Drawing 8]



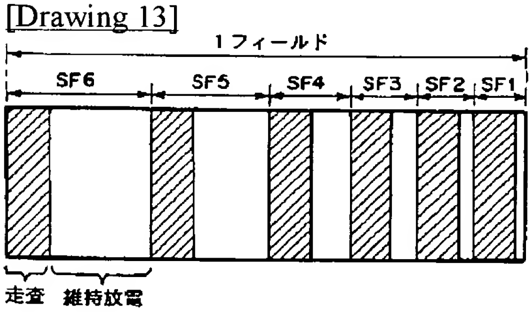
[Drawing 9]



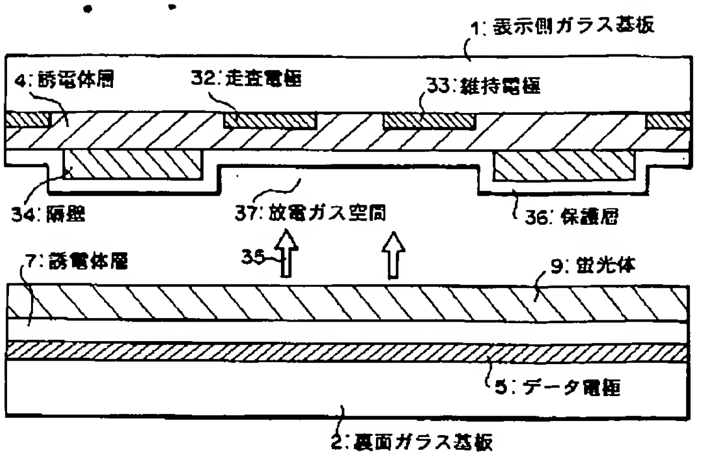
[Drawing 10]



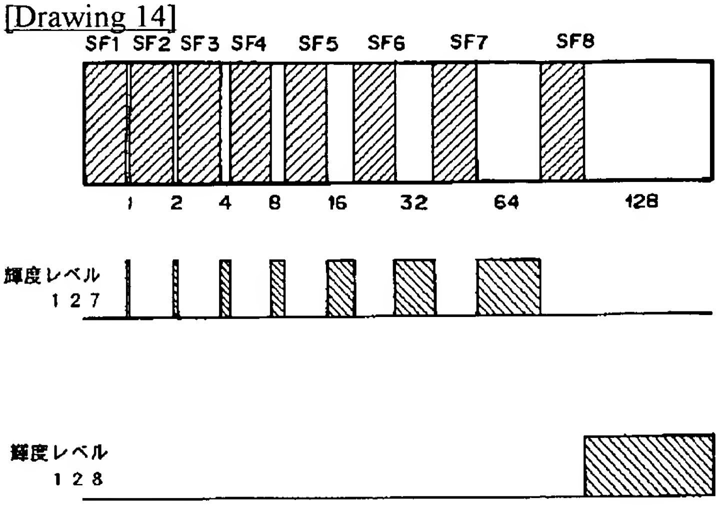
[Drawing 13]



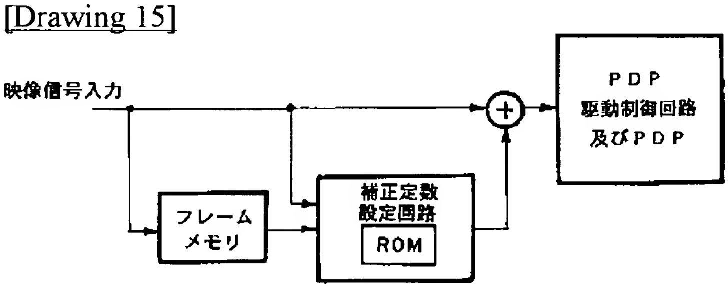
[Drawing 11]



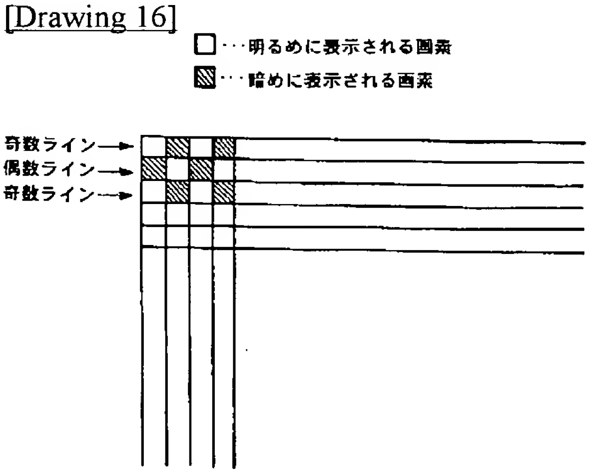
[Drawing 14]



[Drawing 15]



[Drawing 16]



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[Translation done.]

DEVICE AND METHOD FOR GRADATION DISPLAY

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Inventor(s):	OKAJIMA KENJI; NOMURA MASAHIDE
Applicant(s)::	NEC CORP
Requested Patent:	☐ JP11224074
Application Number:	JP19980027126 19980209
Priority Number(s):	
IPC Classification:	G09G3/20 ; G09G3/28 ; H04N5/66
EC Classification:	
Equivalents:	JP3068047B2

Abstract

PROBLEM TO BE SOLVED: To conduct a correct compensation for luminance signals and to greatly increase the dynamic image spurious profile prevention effect by determining the combination of the light emitting subfields, which are suitable in generating the desired luminance in a present frame from the past subfield light emitting history, and the luminance signals in the present frame.
SOLUTION: A light emitting subfield storage section 22 stores the light emitting subfields of the past frames which consists of a previous frame or the previous frame and the frame that is one of the frames existed before the previous frame. A light emitting subfield determining section 21 is provided with a ROM 25 in which the data, that indicate which subfield should be light emitted in order to generate a desired luminance given by the luminance signals, are beforehand stored as the table corresponding to the subfield light emitting pattern in the previous field. Then, a determination is made for the combination of the light emitting subfields which are suitable to generate the desired luminance in the present frame.

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					６４１Ｅ
	3/28			3/28	Ｋ
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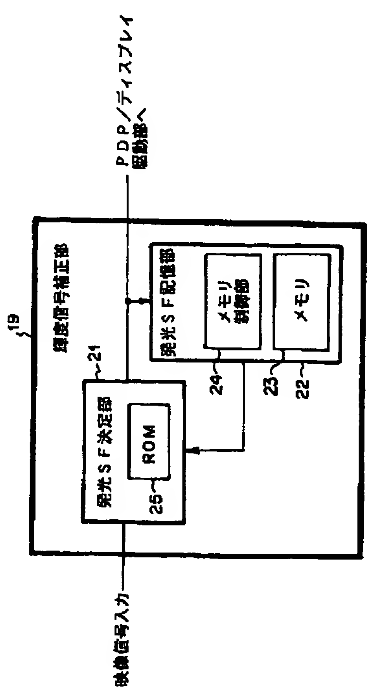
(54)【発明の名称】　階調表示装置および階調表示方法

(57)【要約】
【課題】　動画像偽輪郭による画質の低下を抑制し、高品質の画像を表示する。
【解決手段】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段２２と、発光サブフィールド記憶手段２２により記憶されている過去のサブフィールド発光履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定する発光サブフィールド決定手段２１と、を有する。



【特許請求の範囲】
【請求項１】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、
前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、
該発光サブフィールド記憶手段により記憶されている過去のサブフィールド発光履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定する発光サブフィールド決定手段と、
を有することを特徴とする階調表示装置。
【請求項２】　請求項１に記載の階調表示装置において、前記発光サブフィールド記憶手段は、前フレームにおける発光サブフィールドのみを記憶する手段であることを特徴とする階調表示装置。
【請求項３】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、
前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、
前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける輝度信号を記憶する輝度信号記憶手段と、
該発光サブフィールド記憶手段および該輝度信号記憶手段により記憶されている過去のサブフィールド発光履歴および過去の輝度信号の履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定する発光サブフィールド決定手段と、
を有することを特徴とする階調表示装置。
【請求項４】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、
前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、現フレームにおける発光サブフィールドを決定する発光サブフィールド決定手段とを有し、
前記発光サブフィールド決定手段は、隣接するＬ画素（Ｌは２以上の自然数）における過去のフレームでのサブフィールド発光パターンを前記発光サブフィールド記憶手段から読み出し、このサブフィールド発光パターンと前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定する手段であることを特徴とする階調表示装置。
【請求項５】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、
前フレームにおける輝度信号を記憶する輝度信号記憶手段と、現フレームにおける発光サブフィールドを決定する発光サブフィールド決定手段とを有し、
前記発光サブフィールド決定手段は、隣接するＬ画素（Ｌは２以上の自然数）における前フレームでの輝度信号を、前記輝度信号記憶手段から読み出し、これと前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定する手段であることを特徴とする階調表示装置。
【請求項６】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、
前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、
前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける輝度信号を記憶する輝度信号記憶手段と、
現フレームにおける発光サブフィールドを決定する発光サブフィールド決定手段とを有し、
前記発光サブフィールド決定手段は、隣接するＬ画素（Ｌは２以上の自然数）における過去のフレームでのサブフィールド発光パターン履歴と、前記Ｌ画素における過去のフレームでの輝度信号履歴とをそれぞれ前記発光サブフィールド記憶手段、および輝度信号記憶手段から読み出し、これらと前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて、前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定する手段であることを特徴とする階調表示装置。
【請求項７】　請求項４、５、６のいずれかに記載の階調表示装置において、
発光サブフィールドを決定する画素の単位、Ｌ画素が２画素であることを特徴とする階調表示装置。
【請求項８】　請求項４、５、６、７のいずれかに記載の階調表示装置において、
前記発光サブフィールド決定手段は、各画素における輝度信号と比べて明るめに表示される画素と暗めに表示される画素とを、画面上にチェッカーボード状に配置するように、各画素での発光サブフィールドの組み合わせを決定する手段を有することを特徴とする階調表示装置。

【請求項９】　請求項１～８のいずれかに記載の階調表示装置において、前記発光サブフィールド決定手段は、パーセプトロン・ニューラルネットワークを用いて各画素での発光サブフィールドを決定する手段であることを特徴とする階調表示装置。

【請求項１０】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、

前フレームまたは前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールド発光履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定することを特徴とする階調表示方法。

【請求項１１】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、

前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける過去のサブフィールド発光履歴と、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける過去の輝度信号の履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定することを特徴とする階調表示方法。

【請求項１２】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、

隣接するＬ画素（Ｌは２以上の自然数）における、前フレームまたは前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームでのサブフィールド発光パターンと、前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定することを特徴とする階調表示方法。

【請求項１３】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、

隣接するＬ画素（Ｌは２以上の自然数）における前フレームでの輝度信号と、前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定することを特徴とする階調表示方法。

【請求項１４】　１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、

隣接するＬ画素（Ｌは２以上の自然数）における、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームでのサブフィールド発光パターン履歴と、前記Ｌ画素における前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームでの輝度信号履歴と、前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて、前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定することを特徴とする階調表示方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は階調表示装置および階調表示方法に関し、とくにプラズマディスプレイパネルなどの表示装置の階調表示における動画偽輪郭抑制に適した階調表示装置および階調表示方法に関する。

【０００２】

【従来の技術】一般にプラズマディスプレイパネル（以下、ＰＤＰと略称する）は、薄型構造でちらつきがなく表示コントラスト比が大きいこと、また、比較的に大画面とすることが可能であり、応答速度が速く、自発光型で蛍光体の利用により多色発光も可能であることなど、数多くの特徴を有している。このために、近年コンピュータ関連の表示装置の分野およびカラー画像表示の分野等において、広く利用されるようになりつつある。

【０００３】このＰＤＰには、その動作方式により、電極が誘電体で被覆されて間接的に交流放電の状態で動作させる交流放電型のものと、電極が放電空間に露出して直流放電の状態で動作させる直流放電型のものとがある。更に、交流放電型には、駆動方式として放電セルのメモリ機能を利用するメモリ動作型と、それを利用しないリフレッシュ動作型とがある。なお、ＰＤＰの輝度は、放電回数即ちパルス電圧の繰り返し数にほぼ比例する。上記のリフレッシュ型の場合は、表示容量が大きくなると輝度が低下するため、小表示容量のＰＤＰに対して主として使用されている。

【０００４】図１１は、交流放電メモリ動作型ＰＤＰの一つの表示セルの構成の概略を例示する断面図である。この表示セルは、ガラスより成る前面および背面の二つの絶縁基板（表示側ガラス基板、裏面側ガラス基板）１及び２が対向配置されている。対向側の絶縁基板１上には、透明な走査電極３２及び透明な維持電極３３と、走査電極３２及び維持電極３３を覆う誘電体層４と、誘電体層４上に形成された隔壁３４と、誘電体４を放電から保護する酸化マグネシウム等から成る保護層３６とが形成される。また対向側の絶縁基板２上には、走査電極３２及び維持電極３３と直交して形成されるデータ電極５と、このデータ電極５を覆う誘電体層７と、放電ガスの放電により発生する紫外線を可視光３５に変換する蛍光体９とが形成される。

【０００５】絶縁基板１と絶縁基板２との間の空間にはヘリウム、ネオンおよびキセノン等またはそれらの混合ガスから成る放電ガスが充填されて、放電ガス空間３７を形成しており、隔壁３４は、この放電ガス空間３７を確保するとともに表示セルを区切るために設けられる。

【０００６】次に、図１１を参照して、選択された表示セルの放電動作について説明する。走査電極３２とデータ電極５との間に放電しきい値を越えるパルス電圧を印加して放電を開始させると、このパルス電圧の極性に対応して、正負の電荷が両側の誘電体４及び７の表面に吸引されて電荷の堆積を生じる。この電荷の堆積に起因する等価的な内部電圧、即ち、壁電圧は、上記パルス電圧と逆極性となるために、放電の成長とともにセル内部の実効電圧が低下し、上記パルス電圧が一定値を保持していても、放電を維持することができず遂には停止する。この後に、隣接する走査電極３２と維持電極３３との間に、壁電圧と同極性のパルス電圧である維持パルスを印加すると、壁電圧の分が実効電圧として重畳されるため、維持パルスの電圧振幅が低くても、放電しきい値を越えて放電することができる。

【０００７】従って、維持パルスを走査電極３２と維持電極３３との間に印加し続けることによって、放電を維持することが可能となる。この機能が上述のメモリ機能である。また、走査電極３２または維持電極３３に、壁電圧を中和するような、幅の広い低電圧のパルス、または、幅の狭い維持パルス電圧程度のパルスである消去パルスを印加することにより、上記の維持放電を停止させることができる。

【０００８】図１２は、ｊ×ｋ個の行、列からなるマトリクス状に表示セルを配列したドットマトリクス表示用のパネルの電極配線を示す図であり、行電極としては互いに平行に配列した走査電極Sc1，Sc2，…，Scj及び維持電極Su1，Su2，…，Sujを備え、列電極としてはこれら走査電極及び維持電極と直交して配列したデータ電極D1，D2，…，Dkとを備える。このパネルの駆動の一周期は予備放電期間と書き込み放電期間と維持放電期間とで構成され、これを繰り返して所望の映像表示を得る。

【０００９】予備放電期間は、書き込み放電期間において安定した書き込み放電特性を得るために、放電ガス空間内に活性粒子及び壁電荷を生成するための期間であり、ＰＤＰパネルの全表示セルを同時に放電させる予備放電パルスと、予備放電パルスの印加によって生成された壁電荷のうち、書き込み放電及び維持放電を阻害する電荷を消滅させるための予備放電消去パルスとを印加する。維持放電期間は書き込み放電期間において書き込み放電を行った表示セルを、所望の輝度を得るために維持放電し、発光させる期間である。

【００１０】予備放電期間においては、まず維持電極Su1，Su2，…，Sujに対して予備放電パルスを印加し、全ての表示セルにおいて放電を起こす。その後、走査電極Sc1，Sc2，…，Scjに消去パルスを印加して消去放電を発生させ、予備放電パルスにより堆積した壁電荷を消去する。

【００１１】続いて書き込み期間では、走査電極Sc1，Sc2，…，Scjに走査パルスを線順次に印加し、更に映像表示データに対応してデータ電極Di（1≦i≦k）にデータパルスを選択的に印加し、表示すべきセルにおいては書き込み放電を発生させて壁電荷を生成する。

【００１２】最後に維持放電期間において、書き込み放電を起こした表示セルのみが、維持パルスによって継続的に維持放電を起こし、１面の発光動作が完了する。

【００１３】ＡＣ型カラープラズマディスプレイで利用されている走査維持分離駆動でのサブフィールド表示を図１３を例にして説明する。１フィールドは通常フリッカーの見えない６０分の１秒程度とされるが、図１３に示すように、これは、走査期間、放電期間からなるサブフィールドＳＦ１からＳＦ６の６個のサブフィールドに分割されている。サブフィールドＳＦ６の走査期間では、最上位ビットのＢ５の表示データに基づき各画素に書き込みが行われる。全面書き込みが終了した後、パネル全面に維持放電パルスが印加され、書き込み画素だけを発光表示させる。次に、サブフィールドＳＦ５においても同様の駆動が行われる。各サブフィールドの維持放電期間には、十分な輝度を得るため、例えばサブフィールドＳＦ６では２５６回、サブフィールドＳＦ５では１２８回、サブフィールドＳＦ４からＳＦ１ではそれぞれ６４、３２、１６、８回の維持放電パルスが印加され発光される。

【００１４】この様なサブフィールド法の採用は、発光輝度を発光回数や発光期間で変調する必要から生じており、当然１フィールド期間に複数回の走査を行うために、短時間での走査、書き込みを行う高速性が要求されるが、近年、プラズマディスプレイパネルの書き込み性能の向上が図られ、３マイクロ秒以下でも書き込みが可能となってきており、８サブフィールドによる２５６階調のフルカラー表示も実現されてきている。

【００１５】この様なサブフィールド方式では、静止画の場合は良好な階調表示が再現されるが、動画表示では映像により妨害が発生する。例えば、人物の頬のように滑らかに明るさが変化する画像が画面上を移動した場合に、本来滑らかな画像であるべき頬の部分に暗い輪郭や、明るい輪郭、あるいは異なる色の輪郭が出現する。また、色ずれ、解像度の低下感などをもたらす。この様な動画偽輪郭は、滑らかな階調変化の中で上位ビットに繰り上がる境界で非常に目立ち、著しく表示品位、画質を損なってしまう問題がある。

【００１６】図１４は、８ビットの２進数Ｂ７、Ｂ６、Ｂ５、Ｂ４、Ｂ３、Ｂ２、Ｂ１、Ｂ０に各々対応した輝度１２８、６４、３２、１６、８、４、２、１に重み付

けされた８個のサブフィールドＳＦ８～ＳＦ１の組み合わせによって実現される階調の一部を示す。これらのサブフィールドを組み合わせることにより、２５６階調の表示が可能となる。即ち、各画素の２５６階調の輝度はＢ７～Ｂ０の8ビットの２進数で表現できる。輝度１２８、６４、３２、１６、８、４、２、１の有無を２進数Ｂ７～Ｂ０で表現したサブフィールドＳＦ８～ＳＦ１で画像を順次に表示させ、視覚の積分効果により中間調で表現された自然な画像となる。

【００１７】図１４において、特に輝度１２７から輝度１２８に１階調変化する場合、Ｂ６～Ｂ０の値が、全て”１”から全て”０”に大きく変化し、Ｂ７が”０”から”１”にかわる。このため、最下位のサブフィールドＳＦ１から最上位のサブフィールドＳＦ８の時間順で発光させるとすると、発光期間がフィールドの前半部から後半部に著しく変化することになり、この結果、動画偽輪郭が発生する。

【００１８】この問題を解決するために、いくつかの方法は提案されている。電子通信学会論文誌’７７／Ｖｏｌ Ｊ６０－ＡＮｏ．１の５６頁から６２頁に記載されている滝川氏の論文「ＡＣプラズマパネルによるＴＶ表示」では、１フィールド相当の時間内における輝度の重心位置が、ビットの繰り上がりや繰り下がりの前後で、できるだけ移動しないようにサブフィールドを配列することが有効であり、５ビット即ち３２階調表示の例では、上位ビットの発光期間を中央部に配したＳＦ３、ＳＦ４、ＳＦ５、ＳＦ１、ＳＦ２のサブフィールド配列が動画偽輪郭の抑制に有効であるとしている。また、１フィールド内の表示時間を減少させることも有効であり、実験例では１フィールドの４分の１の時間に表示期間を短縮することにより、前述のサブフィールド配列と組み合わせ、良好な表示が実現されている。

【００１９】また、１９９０年に報告された電子情報通信学会技術報告のＥＩＤ９０－９の鴻上氏の論文「メモリ型ガス放電パネルを用いたテレビの中間表示方式」では、フィールドの最初のビットから次のフィールドの最後のビットまでの時間間隔が、人間の視覚の臨界融合周波数である２０ミリ秒以内とすることにより動画偽輪郭を改善できるとしており、上述の滝川氏の方法と同様、１フィールド全体に渡ってサブフィールドを配置せず、一方に詰めることにより２０ミリ秒以内とすることができ動画偽輪郭が改善されるとしている。

【００２０】また、発光期間が長い上位のビットを分割し配列することによっても、この条件を満たすことができるとしている。８ビット表示の場合、上位のＢ７をＳＦ８－１とＳＦ８－２に、Ｂ６をＳＦ７－１とＳＦ７－２にそれぞれ2分割し、各々分割されたサブフィールドを離散的に配置した、ＳＦ７－１、ＳＦ８－１、ＳＦ１、ＳＦ２、ＳＦ３、ＳＦ４、ＳＦ５、ＳＦ６、ＳＦ７－２、ＳＦ８－２の順に1フィールドを１０サブフィールド構成で配置することにより、フィールドの最初のビットから次のフィールドの最後のビットまでの時間を１８．８ミリ秒とすることができ、動画の階調乱れが改善されたと報告されている。

【００２１】なお、上記論文では輝度の重みを表す２進数の最上位ビットをＢ１とし、それに対応する最上位のサブフィールドをＳＦ１としているが、本発明では情報処理分野で一般的に用いられている表現に統一して、最下位ビットをＢ０、ｎ桁の最上位ビットをBn-1、最下位のサブフィールドをＳＦ１と表現する。

【００２２】上述のような、サブフィールド配列の最適化、フィールド時間や発光表示期間の短縮、あるいは発光期間の長いサブフィールドを分割するといった方法以外の方法としては、表示信号に補正を加え、点灯予定のないサブフィールドを点灯させたり、逆に点灯予定のサブフィールドを消灯させることによって動画偽輪郭を抑制する方法が知られている。特開平8-54853号公報には、動画偽輪郭領域（特開平8-54853号公報では偽イメージ領域と記載されている）を検出し、この動画偽輪郭領域の輝度が本来の輝度より明るいか否かを判別して、この判別結果に基づいてこの領域の画素の発光を制御するというアイディアが記載されている。さらに、特開平8-123355号公報、また特開平8-211848号公報には、動画から動きベクトルを検出し、それを用いて、発生が予想される動画偽輪郭を抑制するように画素の発光を制御するという方法が記載されている。特開平9-102921号公報には、輝度変化によって生じるビットの繰り上がりを各画素において検出し、その結果に基づいて表示データの補正を行う方法が記載されている。また特開平9-34401号公報には、動画偽輪郭を抑制するための補正信号を予め求めておき、これをルックアップテーブルとして読み出し専用メモリ（ＲＯＭ）に書き込んでおく方法が記載されている。

【００２３】図１５は特開平9-34401号公報に記載されている信号補正方法を示すブロック図である。この方法で補正を行う際には、過去のフレームの輝度信号をフレームメモリに記憶させておき、これと現フレームでの輝度信号とをアドレスとして、ＲＯＭから補正信号を読み出し、これを現フレームでの輝度信号に加算してＰＤＰの駆動制御回路へと送る。ここで予めＲＯＭに記憶させておくべき、動画偽輪郭を抑制するための補正データは、実測データを基にして決めておく。

【００２４】

【発明が解決しようとする課題】以上の従来技術において、サブフィールド順の最適化による方法は、動画偽輪郭が十分に抑制されておらず、高品位映像表示に対してはまだ十分ではない。また、フィールド時間の短縮や発光表示期間の短縮、あるいは多数のサブフィールドを分割する方法では、十分な動画偽輪郭の抑制効果を発揮するには、走査期間をかなり短くする必要がある。これ

は、走査期間の短縮が許容される表示容量の小さなプラズマディスプレイでは対応可能であるが、多階調の動画表示はむしろ表示容量の大きなディスプレイで望まれ、この場合、走査時間をさらに大幅に短縮して駆動することは困難となる。

【0025】信号補正によって動画偽輪郭を抑制する方法は、多数のサブフィールドを用いなくても有効に働く可能性があり、この点では有利であるが、動画の動きベクトルを検出して画素の発光を制御する方法は、動き検出処理の負荷が大きく現時点では実用的とは言いがたい。

【0026】そこで、動き検出処理を行わずに信号補正を行う方法が望まれるが、この場合、従来の技術では実際には動画偽輪郭が十分に抑制できず、やはり、高品位映像表示に対してはまだ不十分であるという問題点があった。

【0027】この理由を分析すると、第1の問題点として、従来の信号補正技術では、過去のフレームにおける輝度信号を用いて現フレームでの補正信号を決定している点が挙げられる。例えば、図13のサブフィールド配置では、発光輝度が32から31に変化する場合、ＳＦ6だけが発光している状態から、ＳＦ6が消光しＳＦ1～ＳＦ5が発光している状態に遷移することになり、この結果、フレームの遷移時に発光が疎になる時間が生じ、このために画面が一瞬暗くなり動画偽輪郭が発生する。これを補正するために、補正信号（例えば＋10）を現フレームでの輝度信号に加算して輝度41を表示する。ところが、ここで例えば次のフレームで輝度41を発生させたい場合を考えてみると、現フレームでは、画素は実際には輝度41を表示したのであるから、次フレームでは、補正は不要なはずなのであるが、現フレームでのもともとの輝度信号は31であるから、従来の方法では、輝度信号が31から41に変化した場合の補正信号（例えば－7）が読み出されてそれが加算されてしまうという不合理が起こってしまっていた。

【0028】第2の問題点としては、実際には、直前のフレームでの発光状態だけではなく、2フレーム以上前の発光状態も現フレームで知覚される輝度に影響を与えるのであるが、従来の方法ではこの点が考慮されておらず、現フレームでの輝度信号と1フレーム前の輝度信号とだけから補正信号を決定していたという点が挙げられる。このため、従来の方法では精度の高い補正ができなかった。

【0029】第3の問題点としては、従来の方法では各画素ごとに信号補正を行っていたが、実際には各画素ごとにではどのような補正を行っても、十分な補正が実現できない場合があるという点が挙げられる。

【0030】（発明の目的）本発明は上記の課題に鑑み、動画偽輪郭の妨害を著しく抑制する階調表示装置および階調表示方法を提供することを目的とする。

【0031】

【課題を解決するための手段】本発明の階調表示装置は、1フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、該発光サブフィールド記憶手段により記憶されている過去のサブフィールド発光履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定する発光サブフィールド決定手段と、を有することを特徴とする階調表示装置である。

【0032】また本発明の階調表示装置は、1フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける輝度信号を記憶する輝度信号記憶手段と、該発光サブフィールド記憶手段および該輝度信号記憶手段により記憶されている過去のサブフィールド発光履歴および過去の輝度信号の履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定する発光サブフィールド決定手段と、を有することを特徴とする階調表示装置である。

【0033】また本発明の階調表示装置は、1フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、現フレームにおける発光サブフィールドを決定する発光サブフィールド決定手段とを有し、前記発光サブフィールド決定手段は、隣接するＬ画素（Ｌは2以上の自然数）における過去のフレームでのサブフィールド発光パターンを前記発光サブフィールド記憶手段から読み出し、このサブフィールド発光パターンと前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定する手段であることを特徴とする階調表示装置である。

【0034】また本発明の階調表示装置は、1フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置

において、前フレームにおける輝度信号を記憶する輝度信号記憶手段と、現フレームにおける発光サブフィールドを決定する発光サブフィールド決定手段とを有し、前記発光サブフィールド決定手段は、隣接するＬ画素（Ｌは２以上の自然数）における前フレームでの輝度信号を、前記輝度信号記憶手段から読み出し、これと前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定する手段であることを特徴とする階調表示装置である。

【００３５】また本発明の階調表示装置は、１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示装置において、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールドを記憶する発光サブフィールド記憶手段と、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける輝度信号を記憶する輝度信号記憶手段と、現フレームにおける発光サブフィールドを決定する発光サブフィールド決定手段とを有し、前記発光サブフィールド決定手段は、隣接するＬ画素（Ｌは２以上の自然数）における過去のフレームでのサブフィールド発光パターン履歴と、前記Ｌ画素における過去のフレームでの輝度信号履歴とをそれぞれ前記発光サブフィールド記憶手段、および輝度信号記憶手段から読み出し、これらと前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて、前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定する手段であることを特徴とする階調表示装置である。

【００３６】本発明の階調表示方法は、１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、前フレームまたは前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける発光サブフィールド発光履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定することを特徴とする階調表示方法である。

【００３７】また本発明の階調表示方法は、１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける過去のサブフィールド発光履歴と、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームにおける過去の輝度信号の履歴と、現フレームでの輝度信号とから、現フレームにおいて所望の輝度を発生するのに適する発光サブフィールドの組み合わせを決定することを特徴とする階調表示方法である。

【００３８】また本発明の階調表示方法は、１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、隣接するＬ画素（Ｌは２以上の自然数）における、前フレームまたは前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームでのサブフィールド発光パターンと、前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定することを特徴とする階調表示方法である。

【００３９】また本発明の階調表示方法は、１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、隣接するＬ画素（Ｌは２以上の自然数）における前フレームでの輝度信号と、前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定することを特徴とする階調表示方法である。

【００４０】また本発明の階調表示方法は、１フィールド期間を複数のサブフィールドに分割し、そのサブフィールドの組み合わせにより階調を表示する階調表示方法において、隣接するＬ画素（Ｌは２以上の自然数）における、前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームでのサブフィールド発光パターン履歴と、前記Ｌ画素における前フレーム、または前フレームと該前フレームより前の少なくとも一つのフレームとからなる過去のフレームでの輝度信号履歴と、前記Ｌ画素における現フレームでの輝度信号とから、現フレームにおいて、前記Ｌ画素全体として所望の平均的輝度を発生するのに適する発光サブフィールドの組み合わせを、前記Ｌ画素それぞれに対して、決定することを特徴とする階調表示方法である。

【００４１】（作用）既に説明した図１５の信号補正方法では、過去のフレームにおける、もともとの輝度信号と、現行フレームの輝度信号とから、現フレームに適するサブフィールドの発光パターンを決定していたが、本発明では、過去のフレームにおける、もともとの輝度信号ではなく、輝度信号に補正を施した信号、すなわち実際に発光させたサブフィールドを表す信号を発光サブフィールド記憶部に記憶しておき、発光サブフィールド決定部が、この信号（実際に発光させたサブフィールドを

表す信号）と、現フレームでの輝度信号とから望ましい補正を決定し、現フレームで最も適したサブフィールドの発光パターンを決定する。

【0042】これによって、過去のフレームにおける入力輝度信号と実際に発光させた信号とが異なっている場合にも、実際に発光させたものとは異なる入力輝度信号に基づいて補正が行われてしまうという従来方法の不合理が解消され、著しい動画偽輪郭抑制効果を実現できる。

【0043】また、本発明では、過去の複数のフレームにおけるサブフィールド発光パターンを、複数のフレームメモリを有する発光サブフィールド記憶部に記憶させておき、これらの過去のサブフィールド発光パターンと現フレームでの輝度信号とから、現フレームで最も適したサブフィールド発光パターンを発光サブフィールド決定部が決定する。この結果、入力輝度信号の時間変化履歴に応じて、直前のフレームにおける発光サブフィールドだけでなく、２フレーム以上前のフレームにおける発光サブフィールドの影響も考慮された信号補正、発光サブフィールドの決定が可能になり、より精度の高い補正が実現できる。

【0044】さらに、本発明では、過去のフレームにおけるサブフィールド発光パターンを発光サブフレーム記憶部に記憶させておき、隣接する２画素（一般にはＬ画素。Ｌは２以上の正の整数）における過去の発光サブフィールドと、現フレームにおける上記２画素での輝度信号とから、現フレームで上記２画素それぞれにおいてどのサブフィールドを発光させるべきかを発光サブフィールド決定部が決定する。これによって、従来方法のような各画素ごとに行う補正処理では十分な補正が不可能な場合でも、隣接する２画素全体として補正誤差をキャンセルさせ、平均的に所望する輝度をより精度良く発生することが可能となり、著しい動画偽輪郭の抑制効果が得られる。これが可能になる理由を補足すると次の通りである。１フィールド中に配置するサブフィールドの数をｎとすると、１フィールドで各画素が取りうる発光状態の数は概ね、２のｎ乗通りとなる。各画素ごとに輝度補正を行う方法では、これらの限られた状態の中から最適な発光状態を選択しなくてはならない。それに対して、例えば、２画素全体として平均的に所望する輝度を発生させる場合には、より多くの可能な発光状態の中から最適な発光状態を選択することができる。この場合、可能な発光状態は、各サブフィールドごとに、「２画素とも非発光」、「２画素とも発光」、「どちらかの画素のみが発光」の３通り存在するので、全体としては、３のｎ乗通りの可能な発光状態の中から最適な発光状態を選択できることになる。従って、このように２画素単位で信号補正を行うことによって、最適な発光状態を、より多くの発光状態の中から選択できるため、より精度よく所望する平均的輝度を発生することが可能になる。

【0045】

【実施例】以下、図面を参照し、本発明の好適な実施例に基づいて詳細に説明する。

（第１実施例）まず、本実施例に係わるプラズマディスプレイパネルについて説明する。

【0046】図5は作成した６４０×４８０カラー画像表示用のプラズマディスプレイパネルを示す。表示側となるガラス基板１上に、金属のバス電極が積層された透明導電膜からなる面放電電極３と、表面に酸化マグネシウム膜が付着された誘電体層４が形成されており、更に黒色の格子状の隔壁６が画素を確定するように形成されている。

【0047】裏面側のガラス基板２上にはデータ電極５と白色誘電体層７、ストライプ状の白色隔壁８が形成され、白色隔壁８の溝の中には三原色で発光する蛍光体９が塗り分けられている。

【0048】２枚のガラス基板の間には、ヘリウムＨｅ、ネオンＮｅ、キセノンＸｅからなる放電ガスが封入され、パネルが完成される。データ電極5は１９２０本、面放電電極３は走査電極と維持電極からなり、それぞれ４８０本が形成されている。

【0049】走査電極には順次に走査パルスが印加され、それに同期して選択されたデータ電極５にデータパルスが印加される。この線順次走査がパルス全面に渡って行われた後、パネル全面で維持放電を行わせ、カラー発光が得られる。この様な動作を、６０分の１秒のフィールド期間に、ディジタル化された階調データに対応させて複数のサブフィールドで行い、中間調を有する動画表示を行った。

【0050】図3は、本実施例の概略的構成を示すブロック図である。外部から入力された輝度信号は、輝度信号補正部１９において変換された上で、ＰＤＰ／ディスプレイ駆動制御部２０に送られ、ＰＤＰの発光が行われる。

【0051】図4はＰＤＰ／ディスプレイ駆動制御部の構成の概略を示すブロック図である。パネルから出ているデータ電極５（5-1～５-m）は１本ごとにデータドライバ１０に接続され、そのデータドライバ１０によって書き込み走査期間にデータパルスが各データ電極５-1～５-mに印加される。また、走査電極１１（１１-1～１１-n）は、個別に走査ドライバ１２に接続されている。この走査ドライバ１２により走査電極１１-1～１１-nに走査パルスが印加され、データ電極５に印加されたデータパルスとともに、以後の発光に必要な壁電化が蓄積される。

【0052】一方、維持電極１３はＰＤＰの全ての表示ラインに沿って共通に接続されている。そして、維持ドライバ１４により維持パルスが維持電極１３を介してＰＤＰ全面に印加される。

【0053】データドライバ１０，走査ドライバ１２，

維持ドライバ14は、ドライバ制御回路15によって制御される。ドライバ制御回路15は、データドライバ制御回路、走査ドライバ制御回路、維持ドライバ制御回路とを含んで構成されている（図面上では省略）。データドライバ10はデータドライバ制御回路に接続されており、データドライバ制御回路は、表示データ信号（R7～0、G7～0、B7～0）をフレームメモリ16から取り込み、そこから選択されるべきデータをデータ電極5に供給する。フレームメモリ16には、輝度信号補正部から入力した信号が、前処理部17において逆ガンマ補正等の前処理を受けた上で、供給され記憶される。

【0054】また、走査ドライバ12は、走査ドライバ制御回路に接続されており、1フィールドやフレームの開始を制御する信号である垂直同期信号VSYNCに応答して、走査電極11を順次選択的に駆動する。駆動タイミングは垂直同期信号VSYNCに同期して動作するタイミング制御回路18が発生するタイミングパルスにより決められる。

【0055】次に図1を参照して、本発明の特徴部分である輝度信号補正部19について説明する。図1に示すように、輝度信号補正部19は、発光サブフィールドを決定する発光サブフィールド（SF）決定部21と、前フレームにおける発光サブフィールドを記憶する発光サブフィールド（SF）記憶部22とから構成されている。

【0056】発光サブフィールド記憶部22は、メモリ23と、その入出力を制御するメモリ制御部24とからなっている。

【0057】発光サブフィールド決定部21は読み出し専用メモリ（ROM）25を具備しており、これには、輝度信号によって与えられる所望の輝度を発生させるには、どのサブフィールドを発光させるべきかを示すデータが、前フレームにおけるサブフィールド発光パターンに応じたテーブルとして予め記憶されている。この発光させるべきサブフィールドに関するデータは、対象とするPDP及びサブフィールド配置に対して、予め発光パターンと知覚される輝度との関係を実測して、この実測データを基に決定しておく。発光パターンと知覚される輝度との関係が計算で求められる場合には、計算によってこのテーブルを作成しておいても良い。

【0058】図2には、本実施例で用いたサブフィールドの、フレーム中での配置を示す。各サブフィールドは、予備放電及び書き込み放電のための走査期間と、維持放電期間とからなっている。ここで、SF1～SF5、及びSF8は、各々輝度1、2、4、8、16、及び128に重みづけがされている。SF6－1、SF6－2、及びSF7－1、SF7－2については、それぞれ輝度32、64の重みを2等分した輝度16（SF6－1、SF6－2）、及び輝度32（SF7－1、SF7－2）に重みづけがされている。これらのサブフィールドは、8ビットの2進数の各ビット、B7，B6，B5，B4，B3，B2，B1，B0にそれぞれ対応づけられており、B7～B0が1か0かに応じて、それぞれSF8～SF1が発光、あるいは非発光となる。例えば2進数00011111＝32は、「SF1～SF5が発光、それ以外のサブフィールドが非発光」に対応し、また2進数11000000＝192は、「SF1～SF5、SF6－1，SF6－2が非発光、SF7－1，SF7－2及びSF8が発光」に対応する。本発明で、静止画を表示する場合には、8ビット256階調の輝度信号が、そのまま上記の対応関係に従ってサブフィールドの発光／非発光パターンに変換されるので、このPDPは256階調の輝度を表示することができる。本実施例では、図2に示すごとく、SF8の両側にSF7－1，SF7－2およびSF6－1，SF6－2をそれぞれ対称的に配置しており、これによって、ビット繰り上がり時における発光サブフィールドの輝度重心位置変動が低減するように配慮されている。この結果、本実施例では、サブフィールドの配置自体によっても動画偽輪郭がある程度抑制されるように工夫が施されている。

【0059】以下に、発光サブフィールド決定部21の動作について説明する。例えば、今、ある画素では前フレームにおいてサブフレームSF1～SF5が発光、その他のサブフィールドが非発光であったとする。この発光パターンは2進数00011111＝31に対応する。また、この画素における現フレームでの輝度信号が「32」であるとする。発光サブフィールド決定部は、前フレームにおける発光パターン、この場合には「31」を発光サブフィールド記憶部22から読み出し、これと、現フレームにおける輝度信号、「32」とをアドレスとしてROM25から、現フレームでの望ましい発光パターン、例えば「サブフレームSF6－1，SF6－2、SF2、SF1の発光」に対応する2進数00100011＝35を読み出し、それをPDP／ディスプレイ駆動制御部へと送る。PDP／ディスプレイ駆動制御部は、この信号を受け、この画素において、サブフレームSF6－1，SF6－2，SF2，SF1を発光させ、動画偽輪郭の発生を抑制する。それに対して、例えば、現フレームでの輝度信号が「32」で、前フレームにおける発光パターンも「32」である場合には、ROMからは現フレームの輝度信号と一致する信号、00100000＝32が読み出される。すなわち、例えば、静止画を表示する場合のように、現フレームでの輝度信号が前フレームにおけるSF発光パターン（に対応する2進数）と一致する場合には、現フレームの輝度信号と一致する信号がROMから読み出されるので、それがそのまま表示される。このように本発明においては、同じ輝度信号が入力した場合にも、前フレームにおけるサブフレーム発光パターンに応じて、異なるサブフレーム発光パターンが現フレームにおいて選択され、それが表示

される。

【0060】このようにして選択された、現フレームにおける発光サブフィールドのパターンは発光サブフィールド記憶部に送られそこで記憶され、次のフレームにおける発光パターン決定の際に使用される。

【0061】動画偽輪郭が生じる原因は、前フレームでの発光サブフィールドが占める時間的位置と、現フレームでの発光サブフィールドの時間的位置との相互関係によって、フレームの遷移時に発光が密あるいは疎の時間が生じ、その結果、所望する輝度とは異なる輝度が実際には発生してしまうことにある。特開平9-34401号公報に記載の従来技術では、前フレームにおける輝度信号を参照して、現フレームで所望する輝度を発生させるための発光サブフィールドを決定している。しかし、この場合には、前フレームにおいて実際に発光させたサブフィールドは、前フレームにおける輝度信号とは必ずしも一致しなくなるため、例えば、実際には補正が不要な場合にも補正がなされていまうという不合理が生じてしまうという問題点があった。それに対して、本発明では、前フレームにおける実際の発光サブフィールドをメモリに記憶させ、それを参照して現フレームでの最適発光サブフィールドを決定するという構成になっているため、このような不合理が解消され、より効果的に動画偽輪郭の抑制をはかることが可能になった。

（第２実施例）図６は、本発明による第２の実施例における輝度信号補正部１９の概略を示すブロック図である。図６に示す輝度信号補正部１９は、過去３フレーム（一般には過去Mフレーム。Mは正の整数）にわたって、各画素がどのサブフィールドを発光させたかを記憶する発光サブフィールド記憶部２２と、これによって記憶されている過去のフレームでの発光パターンを読み出し、それと、現フレームで所望する輝度を表す輝度信号とから、現フレームでのサブフィールド発光パターン、すなわちどのサブフィールドを発光させるべきかを決定する発光サブフィールド決定部２１とから構成されている。発光サブフィールド記憶部２２は、各画素における３フレーム分の発光サブフィールドパターンを記憶できるメモリ２３（２３-1，２３-2，２３-3）と、メモリの入出力を制御するメモリ制御部２４とからなる。発光サブフィールド決定部２１は、実施例１の場合と同様にＲＯＭテーブルを用いて実現しても良いが、本実施例では、これは、２５入力、８出力の３層パーセプトロンニューラルネットワーク２６を用いて構成されている。

【0062】ここで、本実施例における発光サブフィールド決定部２１について説明する。まず、過去の発光パターン履歴、及び現フレームでの輝度信号に応じた、望ましい発光パターンは、対象とするＰＤＰおよびサブフィールド配置に対して、発光パターンと知覚される輝度との関係を実測して、この実測データに基づき予め決定しておく。発光パターンと知覚される輝度との関係が計算で求められる場合には計算によってこのテーブルを作成しておいても良い。本実施例では、この発光パターンを与えるテーブルを、２５入力、８出力の３層パーセプトロンニューラルネットワーク（ＮＮ）２６に学習させてある。この３層パーセプトロンニューラルネットワーク２６は、ＤＳＰ（デジタル信号処理用チップ）等で構成することも可能であるが、本実施例では、この３層パーセプトロンニューラルネットワークによる処理は、プロセッサー（図面上省略）と、処理に必要なデータを記憶させたＲＯＭ（図面上省略）とによって実現されている。従って、以下に説明するニューラルネットワークにおいて、入力ノード、中間ノード、出力ノード等は、本実施例では実際上は存在せず、これらはプロセッサーによる処理の手順を説明するための仮想上のものである。

【0063】３層パーセプトロンニューラルネットワーク、およびそれで用いられる学習法（誤差逆伝播学習法）については、例えば、中野馨監修、飯沼一元編「ニューロコンピュータ」（技術評論社1989年発行）に詳しい解説がなされている。ここで、この３層ニューラルネットワークについて説明する。これは、入力ノード層、中間ノード層、出力ノード層とから構成される。また、本実施例で用いた、サブフィールドの時間的配置は、実施例１で用いたものと同じで、図２に示されている通りである。これらのサブフィールドの発光パターンを８桁の２進数で表記する規則も、実施例１の場合と同じである。３層ニューラルネットワークの入力ノードのうち、１から８には、３フレーム前のサブフィールド発光パターンに対応した数値「１」もしくは「０」が入力する。即ち、３フレーム前において、例えばＳＦ１からＳＦ４が発光で、それ以外が非発光であった場合には、ノード１から４には数値「１」が、ノード５から８には数値「０」が入力する。同様にしてノード９から１６には、２フレーム前の発光パターンに対応する数値が、ノード１７から２４には１フレーム前の発光パターンに対応する数値がそれぞれ入力する。入力ノード２５には、現フレームで所望する輝度（現フレームでの輝度信号）を表す数値が入力する。このニューラルネットワークは、これらの入力から、望ましいサブフィールド発光パターンを出力するように、その入出力関係を予め学習してある。従って、これらの入力を処理することによって、出力ノード１から８には、現フレームにおける、望ましいサブフィールド発光パターンに対応する数値、「０」もしくは「１」がそれぞれ出力される。例えば、出力ノード１、３、５における出力が「０」で、その他の出力ノードにおける出力が「１」であった場合、ＳＦ１、ＳＦ３、ＳＦ５が非発光、その他のサブフィールドが発光という発光パターンを表示すべきことを意味する。

【0064】このニューラルネットワークの動作は次のようである。入力ノードに数値が入力すると、j番目の中間ノードは、i番目の入力ノードI_iへの入力と、予め

学習しておいた重み係数W_{ji}、及びオフセットθ_jに基づき、次式で表される処理を実行し、その結果を出力ノードへと送る。

【0065】

【数1】

$$H_j = f\left(\sum_i W_{ji} I_i + \theta_j\right)$$

ここで関数f（x）は、u_0を調整パラメータとして、

【0066】

【数2】

$$f(x) = 1 / \{1 + \exp(-2x / u_0)\}$$

で表されるシグモイド関数である。

【0067】次に、各出力ノードは各中間ノードの出力結果H_jと、やはり予め学習によって予め決定してある重み係数V_{kj}、オフセットγ_kとに基づき、次式で表される処理を実行し、その結果を出力する。

【0068】

【数3】

$$O_k = f\left(\sum_j V_{kj} H_j + \gamma_k\right)$$

以上の処理において、各中間ノード、出力ノードが用いる重み係数、W_{ji}、V_{kj}とオフセット値、θ_j、γ_kは、ニューラルネットワークが入力に応じて、望ましい出力を出すように、次のような誤差逆伝播学習法に基づき予め決定しROMに記憶させておく。この誤差逆伝播学習法のアルゴリズムについては、例えば、上記文献、中野馨監修、飯沼一元編「ニューロコンピュータ」（技術評論社1989年発行）等に詳細に記載されている。即ち、各重み係数に対して適当な初期値から出発し、次式に基づいて、ニューラルネットワークの各出力ノードの出力O_kと、予め決定してある望ましい出力T_kとの誤差が、設定許容誤差範囲に収まるようになるまで、各重み係数の修正を繰り返す。

【0069】

【数4】

$$V_{kj} \Leftarrow V_{kj} + \alpha \delta_k H_j$$

$$\gamma_k \Leftarrow \gamma_k + \beta \delta_k$$

$$W_{ji} \Leftarrow W_{ji} + \alpha \sigma_j I_i$$

$$\theta_j \Leftarrow \theta_j + \beta \sigma_j$$

ここでα，βは適当な定数であり、「誤差」δ_k，σ_jはそれぞれ

【0070】

【数5】

$$\delta_k = (O_k - T_k) O_k (1 - O_k)$$

$$\sigma_j = \sum_k \delta_k V_{kj} H_j (1 - H_j)$$

で与えられる。

【0071】ここで発光サブフィールド決定部２１への入力と出力との関係を、実施例１の場合のように、ルックアップテーブルとしてＲＯＭに書き込んでおくことも可能である。しかし、本実施例のように、この部分にニューラルネットワークを用いることによって、全ての入出力関係のテーブルを記憶させる代わりに、各ノードが用いる重み係数とオフセット値だけを記憶させておけば良くなるため、必要な記憶容量を大幅に削減することが可能となる。このような記憶容量削減が可能となる理由は、上記入出力関係を示すテーブルが、実際には、ほとんどの入力に対して何の補正も加えずそのまま出力すれば良い等の、冗長なテーブルになっているためである。ニューラルネットワークは入出力関係に内在する冗長性を学習することができ、その結果、必要な記憶容量を削減する上で有効であることが知られている。この性質を利用して、本発明では入出力関係テーブルの記憶に必要な記憶容量を圧縮している。

【0072】このニューラルネットワークは、ＤＳＰ等で構成することも可能であるが、本実施例では、これは、学習によって予め決定しておいた各ノードの重み係数を記録したＲＯＭと、それを用いて積和演算と、関数ｆ（ｘ）による非線形演算を順次行い、出力を計算するプロセッサーとで構成されている。

【0073】輝度信号補正部１９で変換されたサブフィールド発光パターンは、第１の実施例の場合と同様に、ＰＤＰ／ディスプレイ駆動部２０へと送られ、ＰＤＰの各画素の発光を行う。また、この発光パターンは、１フレーム前のサブフレーム発光パターンとして発光サブフィールド記憶部２２にも送られ、次フレーム以降の発光サブフィールド決定の際に参照される。

【0074】なお、本実施例では、過去３フレームにわたって、各画素がどのサブフィールドを発光させたかを記憶しておき、それに応じて、現フレームでの最適なサブフィールド発光パターンを決定していたが、これに加えさらに、図７に示すように、輝度信号補正部１９に、輝度記憶部２７を設け、過去のフレームにおける輝度信号も併せて記憶しておき、これも考慮に入れた上で、現フレームでの最適発光サブフィールドを決定する構成にすることも可能である。このような構成にすることによって、所望する輝度の過去の時間変化も考慮に入れた発光サブフィールドの決定が可能になり、よりきめの細かい輝度補正が可能になる。なお、図７において発光サブフィールド決定部２１は、やはり３層パーセプトロンニューラルネットワークを用いて構成されている。この場合、入力ノードには、発光サブフィールド記憶部２２に記憶されている過去のフレームにおけるサブフィールド発光パターン、外部から入力する現フレームにおける輝度信号以外に、さらに、輝度記憶部２７に記憶されている過去のフレームにおける輝度信号が併せて入力し、そ

れらに基づいて、予め決定されている最適な発光サブフィールドが出力される。

【0075】なお、図7では、記憶する過去のフレームにおけるサブフィールド発光パターンの数（フレーム数）と、記憶する過去の輝度信号の数（フレーム数）とが同じになっているが、その数が異なっていてもかまわない。

（第3実施例）図8は、本発明による第3の実施例における輝度信号補正部19の概略を示すブロック図である。図8において、輝度ペアー読み出し部28は、走査ラインに沿って隣接する2画素における輝度信号を逐次取り出し、それを発光サブフィールド決定部21へと送る。また、この輝度ペアー読み出し部28は、新しい走査ラインが始まる度に、その走査ラインが偶数番目のラインか奇数番目のラインかに応じて、1か0の値を取る偶奇信号を生成し、やはりそれを発光サブフィールド決定部21へと送る。発光サブフィールド記憶部22は、前フレームにおける実際の発光サブフィールドを、上記2画素ごとに記憶している。この発光サブフィールド記憶部22は、第1の実施例の場合と同様に、メモリとメモリ制御部とからなっている（図面上省略）。

【0076】ここで、本実施例での発光サブフィールド記憶部22におけるデータ形式について説明する。まず、この実施例においても、サブフィールドの時間的配置は実施例1で用いたものと同じで、図2に示されている通りである。今、例えば、前フレームにおいて対象としている2画素のうち、一方の画素では、SF1，SF2，SF6－1，SF6－2が発光、他のサブフィールドが非発光で、もう一方の画素では、SF1，SF3，SF6－1，SF6－2が発光、他のサブフィールドが非発光であったとする。この場合には、8桁の3進数00200112＝500が発光サブフィールド記憶部22に記憶される。つまり、発光サブフィールドのパターンは8桁の3進数に対応づけられ、この8桁の3進数において、ある桁、例えば1桁目の数字が2、もしくは0であった場合には、対象としている2画素いずれにおいても、SF1が発光（2の場合）もしくは非発光（0の場合）であったことを示す。6桁目、7桁目に関しては、これらの桁の数字が2もしくは0であった場合には、いずれの画素においても、SF6－1，　SF6－2（6桁目の場合）もしくはSF7－1，SF7－2（7桁目の場合）が、発光（2の場合）もしくは非発光（0の場合）であったことを示す。また、ある桁、例えば2桁目の数字が1であった場合には、これらの2画素のどちらか一方でこの桁に対応するサブフィールド、今の場合にはSF2が発光していたことを示す。

【0077】発光サブフィールド決定部21は、これらの信号、すなわち発光サブフィールド記憶部22から読み出された、前フレームにおけるサブフィールドの発光パターン、および輝度ペアー読み出し部28から入力してきた現フレームにおける輝度信号とに基づいて、現フレームにおける上記2画素それぞれでの最適なサブフィールド発光パターンを決定する。

【0078】ここで、図9を参照して、この発光サブフィールド決定部21の動作について説明する。まず、輝度ペアー読み出し部28から入力した、上記2画素での現フレームにおける輝度信号は加算されて、2画素全体として平均的に表示されるべき輝度が計算され、これが発光サブフィールド読み出し部29に送られる。発光サブフィールド読み出し部29は、ROM25を具備しており、このROM25には、2画素全体として所望する輝度を発生させるには、2画素全体としてどのサブフィールドを発光させるべきかを、前フレームにおけるこれら2画素でのサブフィールド発光パターンに応じて決定するためのテーブルが予め記憶されている。この発光させるべきサブフィールドに関するデータは、対象とするPDP及びサブフィールド配置に対して、予め発光パターンと知覚される輝度との関係を実測して、この実測データを基に決定しておく。発光パターンと知覚される輝度との関係が計算で求められる場合には、計算によってこのテーブルを作成しておいても良い。ROM25から読み出されたデータは、上述した発光サブフィールド記憶部22における規則と同様に、次のような規則に従って、8桁の3進数で表されている。すなわち、まず、例えば上記2画素いずれにおいてもSF1を発光させるべき時には1桁目の数字は2となる。また、いずれの画素においてもSF1を発光させないときには1桁目の数字は0となる。また、いずれか一方の画素でSF1を発光させ、他方の画素ではSF1を非発光とするときは1桁目の数字は1となる。例えば、ROM25から読み出されたデータが3進数01022100＝954であった場合、いずれか一方の画素でSF7－1，SF7－2，およびSF3を発光、SF4，SF5はいずれの画素でも発光、その他のサブフィールドについてはいずれの画素でも非発光とすべきことを意味する。ROM25から読み出されたデータは、発光サブフィールド記憶部22に送られ、次のフレームにおける最適発光サブフィールドパターンの決定に用いられる。さらに、このデータは発光サブフィールド振り分け部30にも送られる。発光サブフィールド振り分け部30は、ROM25から読み出された上記データを、上記2画素それぞれにおける輝度信号と、輝度ペアー読み出し部28から入力された偶奇信号とに基づいて、上記2画素それぞれに振り分け、それぞれの画素において発光させるべきサブフィールドを確定する。

【0079】この発光サブフィールド振り分け部30の動作について説明する。発光サブフィールド振り分け部30では、ロジック回路によって、次のような規則に従って、発光サブフィールドの振り分けを実行する。まず、上に説明したように、ROM25から読み出された

3進数のデータにおいて、数字が0、もしくは2となっている桁に対応するサブフィールドに関しては、いずれの画素においても、そのサブフィールドは非発光、もしくは発光となり各画素の発光、非発光は一意に決定される。それに対して、上記3進数において、ある桁の数字が1の場合には、その桁に対応するサブフィールドをどちらの画素で発光させるべきかについての自由度が残る。すなわち、例えば、ROM25から読み出されたデータが3進数01022100＝953であった場合、可能な振り分けとしてはB1＝01011100＝92とB2＝00011000＝24，あるいはB1＝01011000＝88とB2＝00011100＝28，あるいはB1＝00011100＝28とB2＝01011000＝88，あるいはB1＝00011000＝24とB2＝01011100＝92の4通りの場合があり得る。この場合、発光サブフィールド振り分け部30は、次のような規則に従って、発光サブフィールドの振り分けを実行する。ここで対象となっている2画素における輝度信号をそれぞれA1，A2とおく。ただし、走査ライン上で、もう1方の画素に対して左側に位置する画素の輝度信号をA1、右側に位置する画素の輝度信号をA2とする。また、B1，B2を発光サブフィールドの可能な振り分けに対応する、それぞれの画素における発光サブフィールドパターンを表す2進数とする。例えば画素1においてSF3，SF4，SF5が発光で、その他のサブフィールドが非発光とさせる場合には、B1は00011100＝28である。

【0080】発光サブフィールド振り分け部30は、まず、B1，B2を、それぞれがA1，A2に最も近くなるように決定する。すなわち次式

【0081】

【数6】$|A1-B1|+|A2-B2|$

を最小にする可能な分割を求める。これが一意に決定される場合には、処理は終了するが、この条件を満たす分割が複数存在する場合には、それらの中でB1，B2ができるだけ均等になるものを決める。すなわち、次にそれらの中で、

【0082】

【数7】$|B1-B2|$

を最小にする分割を求める。これで分割が一意に決定された場合には、処理は終了する。最後に、例えば対象とする2画素における輝度信号、A1とA2とが等しい場合には、どちらの画素にB1あるいはB2を振り当てるかの自由度が残る。この場合には、偶奇信号が0か1かに応じて、

$B1-A1>B2-A2$　（偶奇信号が0の場合）

$B1-A1<B2-A2$　（偶奇信号が1の場合）

という規則に従ってサブフィールドを振り分ける。つまり、現在の走査ラインが、偶数ラインか奇数ラインかに応じて、上記画素ペアーの1番目の画素を、輝度信号と比べて、より明るめに表示するか、暗めに表示するかを切り替える。この結果、図16に示すように、明るめに表示される画素と暗めに表示される画素とが、画面上にチェッカーボード状に配置されることになり、各画素ごとに生じる輝度誤差を全体としては目立たなくさせる効果がある。

【0083】このように、本発明では、各画素ごとにでは完全な輝度補正が不可能な場合であっても、明るめに表示される画素と暗めに表示される画素とが、画面上にチェッカーボード状に配置され、全体としては所望の平均的輝度を発生させ、動画偽輪郭を抑制することが可能である。

【0084】発光サブフィールド振り分け部30は、こうして決定された上記2画素における発光パターン信号、B1，B2をこの順番に出力する。実施例1の場合と同様に、輝度信号補正部19で決定されたサブフィールド発光パターンは、PDP／ディスプレイ駆動部へと送られ、PDPの各画素の発光を行う。

【0085】なお、本実施例では、2画素ごとに、前フレームにおける発光パターンに応じて、最適な発光サブフィールドを決定しているが、過去の複数のフレームにおける発光パターンを記憶しておき、これらを参照して現フレームでの最適発光サブフィールドを決定する構成にすることも可能である。この場合には、発光サブフィールド決定部ではROMテーブルではなく、実施例2で述べたものと同様の3層ニューラルネットワークを用いて、最適発光サブフィールドを決定することが、必要な記憶容量を削減する上では望ましい。さらに、図10に示したごとく、発光サブフィールド記憶部22によって、過去の複数のフレームにおける発光パターンを記憶するとともに、さらに、輝度記憶部27によって、過去の複数のフレームにおける輝度信号をも記憶しておき、これらに応じて、発光サブフィールド決定部19において、現フレームでの最適発光サブフィールドを決定する構成にすることも可能である。これによって必要なフレームメモリや、発光サブフィールド決定部において必要となる記憶容量は増大するが、よりきめの細かい輝度補正が可能となる。

【0086】なお、図10では、記憶する過去のフレームにおけるサブフィールド発光パターンの数（フレーム数）と、記憶する過去の輝度信号の数（フレーム数）とが同じになっているが、その数が異なっていてもかまわない。

【0087】また、発光サブフィールド記憶部22によって、前フレームにおける発光パターンを記憶するとともに、さらに、輝度記憶部27によって、前フレームにおける輝度信号をも記憶しておき、これらに応じて、発光サブフィールド決定部19において、現フレームでの最適発光サブフィールドを決定する構成にすることも可能である。

【００８８】さらに、図１０において、発光サブフィールド記憶部２２を省略し、輝度記憶部２７に記憶してある過去のフレームにおける輝度信号のみを参照して、現フレームにおける最適な発光サブフィールドを２画素ごとに決定する構成にすることも可能である。この方式を採った場合でも、特開平９－３４４０１号公報に記憶されている従来方式に比べると、本発明では隣接する２画素ごとにそれぞれ最適発光サブフィールドを決定する構成になっているため、２画素全体として補正誤差をキャンセルし低減させることが可能であり、動画偽輪郭抑制効果が高まっている。

【００８９】

【発明の効果】以上説明したように本発明では、過去のフレームにおける実際のサブフィールド発光パターンと、現フレームでの輝度信号とから現フレームで最も適したサブフィールド発光パターンを決定する構成にしてあるため、過去のフレームにおける輝度信号と過去のフレームにおけるサブフィールド発光パターンとが対応しないような場合においても、正しく輝度信号補正が行なわれ、動画偽輪郭抑制効果を著しく高める効果がある。

【００９０】また本発明では、過去の複数のフレームにおけるサブフィールドの発光パターンと、現フレームにおける輝度信号とから、現フレームで最も適したサブフィールド発光パターンを決定する構成にしたため、直前のフレームだけでなく、２フレーム以上前のフレームにおける発光サブフィールドの影響も考慮された輝度信号補正が行われ、動画偽輪郭抑制の精度を著しく高める効果がある。

【００９１】さらに、本発明では、過去のフレームにおけるサブフィールド発光パターンと、現フレームにおける輝度信号とから、隣接する２画素ごとに２画素それぞれにおける最適発光サブフィールドを決定する構成にしたため、従来方法のような各画素ごとに行う補正処理では十分な補正が不可能な場合でも、隣接する２画素全体として補正誤差をキャンセルさせることができ、平均的により精度良く所望する輝度を発生することが可能となり、動画偽輪郭抑制効果を著しく高める効果が得られる。

【図面の簡単な説明】

【図１】本発明による第１の実施例における輝度信号補正部を示すブロック図である。

【図２】実施例で用いたサブフィールドのフレーム時間中での配置図である。

【図３】本発明の概略を示すブロック図である。

【図４】本発明の実施例で使用されたPDP及びディスプレイ駆動制御部の概略を示すブロック図である。

【図５】本発明の実施例に使用されるプラズマディスプレイパネル（ＰＤＰ）の構造を示す傾斜視図である。

【図６】本発明による第２の実施例における輝度信号補正部を示すブロック図である。

【図７】本発明による第２の実施例において、過去の輝度信号も考慮した信号補正をする構成にした場合の、輝度信号補正部を示すブロック図である。

【図８】本発明による第３の実施例における輝度信号補正部を示すブロック図である。

【図９】図８の輝度信号補正部における発光サブフィールド決定部を示すブロック図である。

【図１０】本発明による第３の実施例において、過去の輝度信号も考慮した信号補正をする構成にした場合の、輝度信号補正部を示すブロック図である。

【図１１】ＡＣメモリ動作型ＰＤＰの一つの表示セルの構成を示す断面図である。

【図１２】ＡＣメモリ動作型ＰＤＰの電極配置を示す平面図である。

【図１３】従来の階調表示のためのサブフィールド方式の説明図である。

【図１４】動画偽輪郭を説明するためのサブフィールド発光パターンの説明図である。

【図１５】従来技術による信号補正方法を説明するブロック図である。

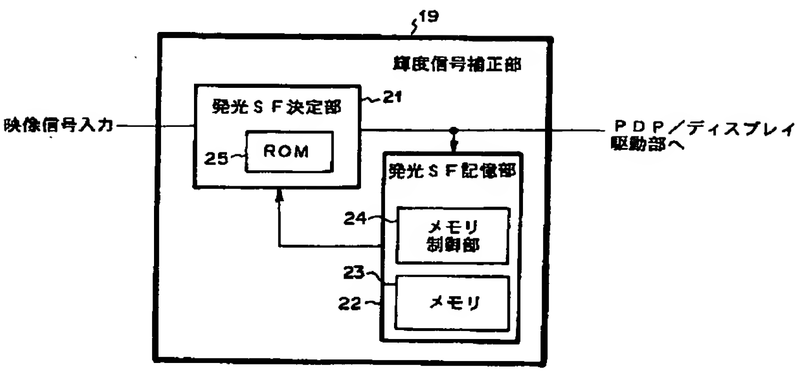
【図１６】本発明による第３の実施例において、信号補正の結果、明るめに表示される画素と暗めに表示される画素の配置の仕方を説明する説明図である。

【符号の説明】

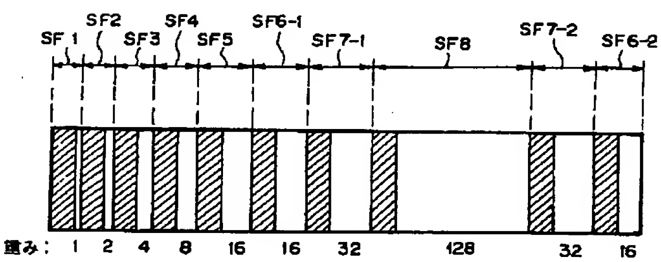
１，　２　絶縁基板
３　面放電電極
４　誘電体層
５　データ電極
６　隔壁（黒）
７　白色誘電体層
８　隔壁（白）
９　蛍光体
１０　データドライバ
１１　走査電極
１２　走査ドライバ
１３　維持電極
１４　維持ドライバ
１５　ドライバ制御回路
１６　フレームメモリ／メモリ制御部
１７　前処理部
１８　タイミング制御回路
１９　輝度信号補正部
２０　ＰＤＰ／ディスプレイ駆動制御部
２１　発光サブフィールド決定部
２２　発光サブフィールド記憶部
２３　メモリ
２４　メモリ制御部
２５　読み出し専用メモリ
２６　ニューラルネットワーク部
２７　輝度記憶部

２８　輝度ペアー読み出し部
２９　発光サブフィールド読み出し部
３０　発光サブフィールド振り分け部

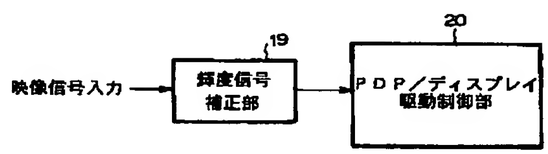
【図1】



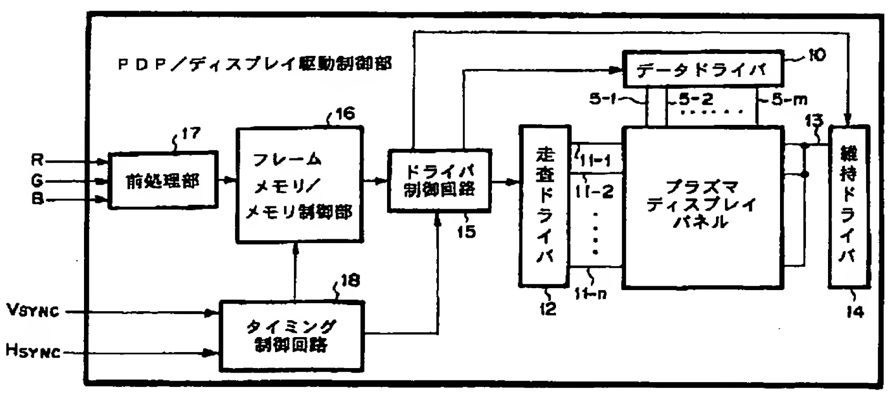
【図2】



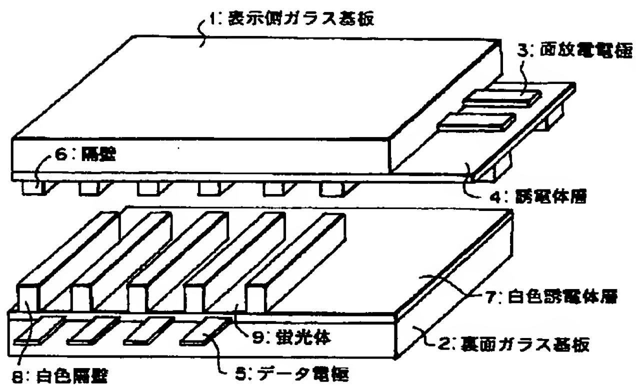
【図3】



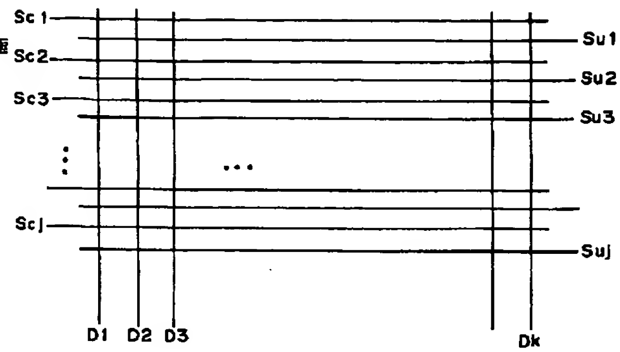
【図4】



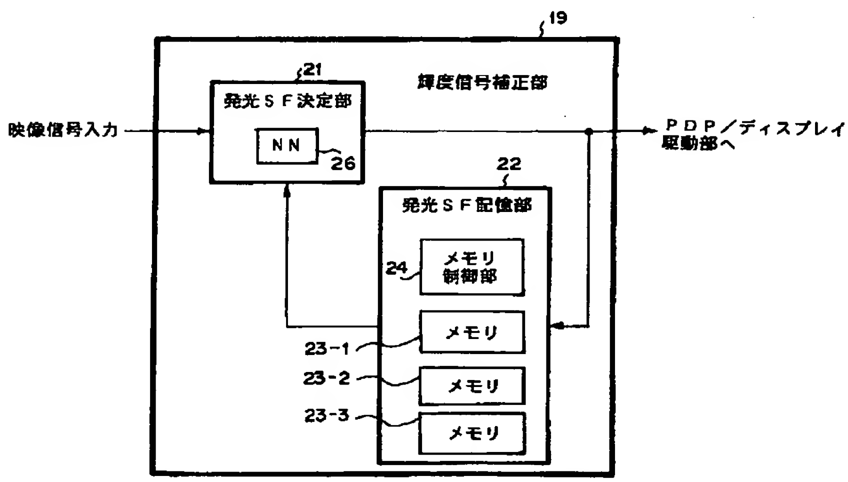
【図5】


1: 表示側ガラス基板
3: 面放電電極
6: 隔壁
4: 誘電体層
7: 白色誘電体層
9: 蛍光体
2: 裏面ガラス基板
8: 白色隔壁
5: データ電極

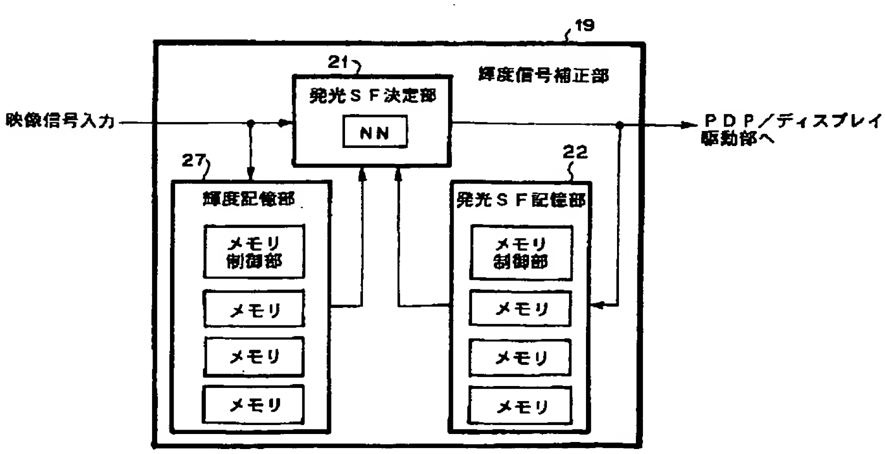
【図12】


Sc1
Sc2
Sc3
Scj
Su1
Su2
Su3
Suj
D1
D2
D3
Dk

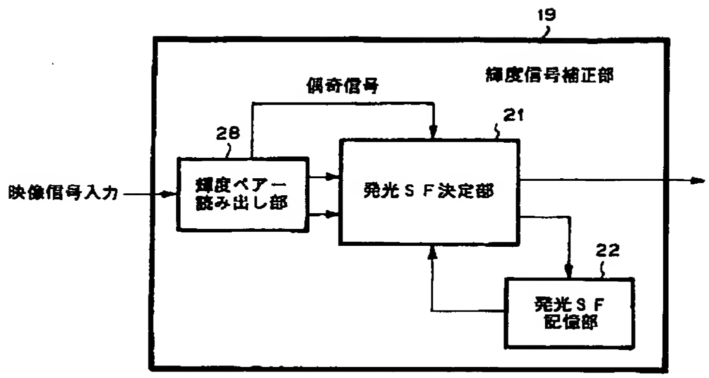
【図6】


19
輝度信号補正部
21
発光ＳＦ決定部
NN
26
映像信号入力
ＰＤＰ／ディスプレイ
駆動部へ
22
発光ＳＦ記憶部
24
メモリ
制御部
メモリ
メモリ
メモリ
23-1
23-2
23-3

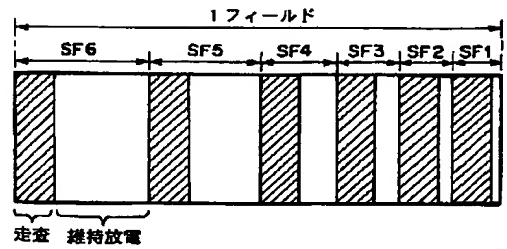
【図7】


19
輝度信号補正部
21
発光ＳＦ決定部
NN
映像信号入力
ＰＤＰ／ディスプレイ
駆動部へ
27
輝度記憶部
メモリ
制御部
メモリ
メモリ
メモリ
22
発光ＳＦ記憶部
メモリ
制御部
メモリ
メモリ
メモリ

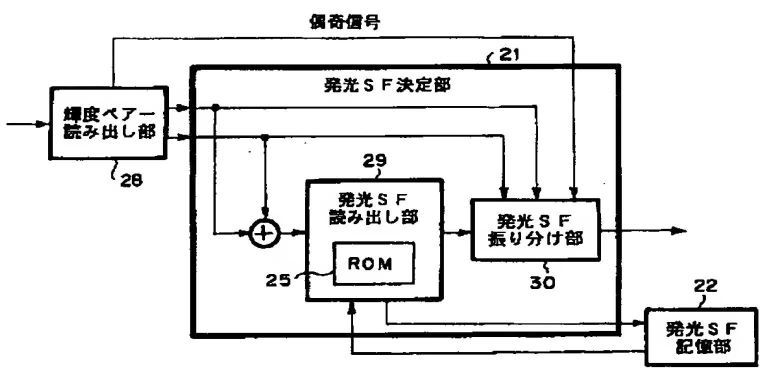
【図8】


19
輝度信号補正部
偶奇信号
21
28
映像信号入力
輝度ペアー読み出し部
発光ＳＦ決定部
22
発光ＳＦ記憶部

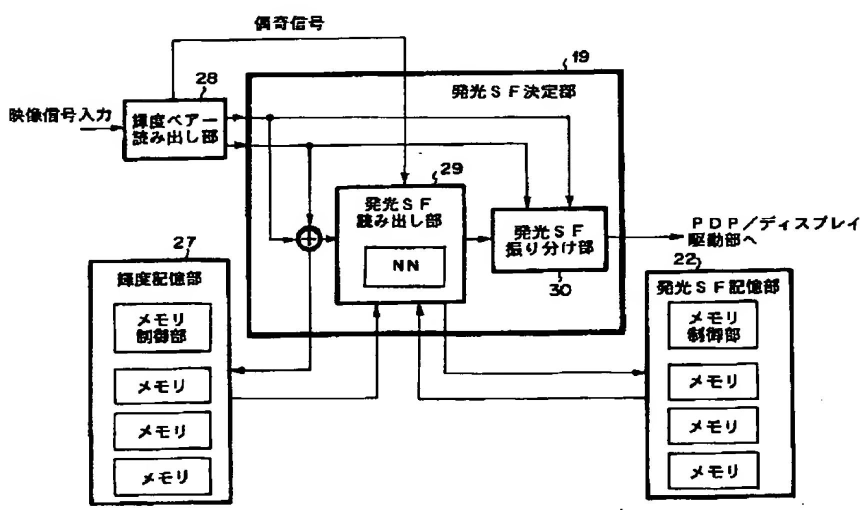
【図１３】


1フィールド
SF6
SF5
SF4
SF3
SF2
SF1
走査
維持放電

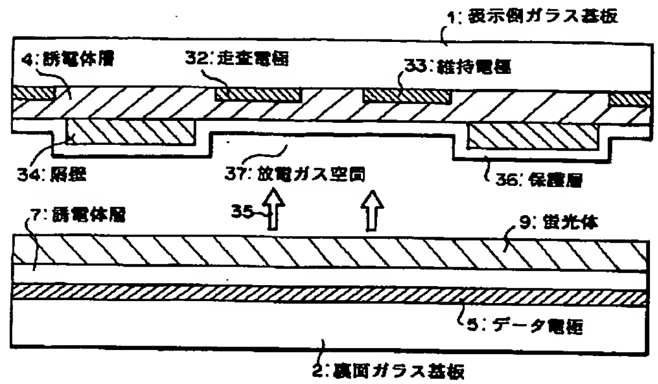
【図9】


偶奇信号
21
発光ＳＦ決定部
輝度ペアー読み出し部
28
29
発光ＳＦ読み出し部
ROM
25
発光ＳＦ振り分け部
30
22
発光ＳＦ記憶部

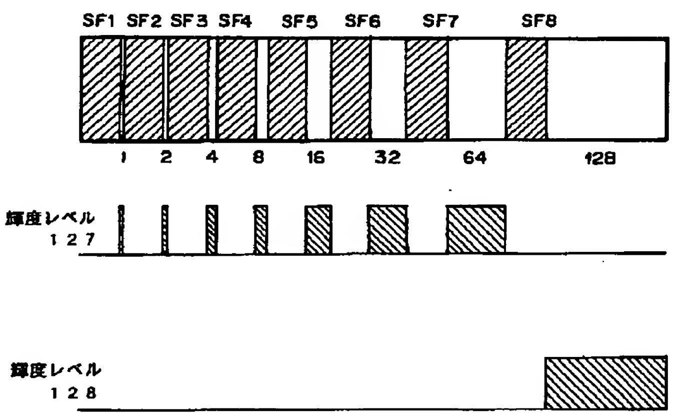
【図１０】


偶奇信号
19
28
発光ＳＦ決定部
映像信号入力
輝度ペアー読み出し部
29
発光ＳＦ読み出し部
NN
発光ＳＦ振り分け部
30
ＰＤＰ／ディスプレイ駆動部へ
27
輝度記憶部
メモリ制御部
メモリ
メモリ
メモリ
22
発光ＳＦ記憶部
メモリ制御部
メモリ
メモリ
メモリ

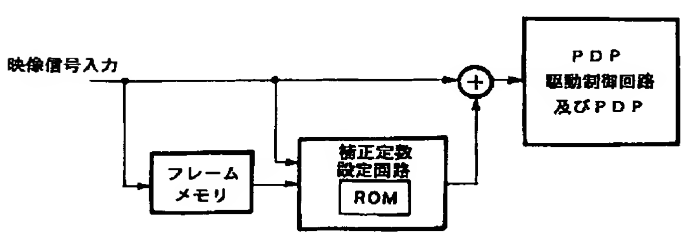
【図11】



【図14】



【図15】



【図16】